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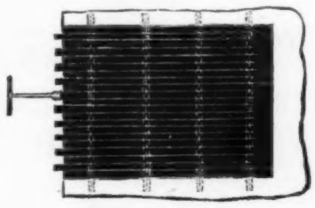
BOILERS OF THE HAVEMEYER SUGAR WORKS.

We give a view of the interior of the boiler house of one of the great sugar refineries of New York. The engraving above shows the boilers in section. There are fifteen of these boilers in all. The illustration explains itself. It is worth notice that all the furnaces have been fitted by Messrs. Martin & Co., of Charterhouse street, London, with the well-known Martin fire door and grate. The door answers the purpose of a deflector, and sends in air over the burning fuel in a very wide and thin stream. We have had some experience with these doors, and we have found them extremely simple and very efficacious in preventing smoke. The grate bars are square, and are turned with a key, as shown in the detail drawing below, in order to clean the fires.

We have made some inquiries as to the results of the use



PLAN OF FIRE BARS.

of the Martin door and grates at Messrs. Havemeyers & Elder's works. We are told that while fitted with ordinary grates and folding doors the consumption of coal was enormous. The Martin door was put on to try to reduce the waste of fuel, with the result that the twelvemonths' continuous run night and day, ending last June, showed a saving of 2,000 tons; the former water evaporation per lb. of coal 8·67 lbs. now it is 10·18 lbs.; a similar result has been obtained at the Standard Sugar Refinery, Boston, Mass. We are unable to say whether any change was made in the dimensions of the grates at the time the new furnaces were put in.

SOLVAY'S DISTILLING APPARATUS FOR THE CONCENTRATION OF GAS LIQUOR FROM GAS WORKS.

By Dr. G. Th. Gerlach.

The apparatus of E. Solvay offers very special advantages for distilling ammoniacal gas liquor. It is constructed to work horizontally, and is heated directly. It also has the advantage of producing a constant motion of the whole fluid mass, by the vapors of distillation being themselves forced through the fluid. It is convenient and not expensive in its arrangement, can be economically worked, is perfectly regular in its operation, and is independent of any special skill in the workmen employed.

The apparatus is particularly remarkable for the principle on which it is constructed, by which the vapors of distillation themselves force on the liquid to be distilled, in a horizontal direction opposite to that of the vapor.

If a gas or vapor rises in a narrow vertical tube, it will raise with itself a certain portion of the liquid, and if the volume of the gas is sufficiently great in proportion to the liquid, and rises with sufficient velocity, the liquid may be raised to a considerable height—greater than it would be by the mere pressure of the gas or vapor, even if this pressure is not perceptibly diminished. This latter circumstance is of the utmost importance if the apparatus is used for washing or absorbing gas, when the loss of pressure is to be avoided.

The apparatus is represented in Figs. 1 to 4.

It consists of a boiler A, divided by the partitions C, into a certain number of divisions, B_1 to B_{12}. Each division contains a jar-shaped cast iron vessel E, connected with the succeeding division, so that the liquid can flow into the latter by the lateral aperture, while the vapor from the *preceding* division enters the same vessel E, through the bent tube T. The fire is applied at F.

The apparatus, therefore, works as follows: The level of the liquid being the same throughout the whole apparatus as far as O, the liquid to be distilled is warmed in the vessel R (which will be explained presently). The warmed liquid passes from R, through the pipe M, into the apparatus A—namely, into the division B, and from thence into the vessel E_1; the vapor produced in the division B_2 also passes through the bent tube T, into E_1. But this vapor forces a portion of liquid over the edge of the vessel E_1 into the division B_1, from whence it can pass into E_2. In the same way the vapor from B_3, entering E_2, forces the liquid into B_2, and thence into E_3, and so on until it reaches the division B_{12}, from which the exhausted liquor runs off through the pipe U, while the products of the distillation escape through the tube V.

If it is required to wash or absorb gas, the gas must be admitted into B_{12}, while the purifying or absorbing liquid flows in through B.

The progress of the liquid in the apparatus depends upon the relative diameters of the bent tubes T, and the vessels E. The circular space between the bent tube and the edge of the jar E, must be duly proportioned to the quantities of liquid and of gas which are required to pass.

R is a condenser for the vapors distilled. Passing through the worm J, they are cooled and condensed by the liquid to be distilled, and which enters cold from the reservoir K, into a small apparatus G, whence its admission into R is regulated by a valve S, which is closed or opened by the float X. According as the liquid is more or less warmed the float falls or rises, and allows more or less of the liquid to pass, so that the more heat is applied, and the more vapor is produced, the more liquor can flow in through the valve S. This float will also act if the products of the liquid to be distilled are variable.

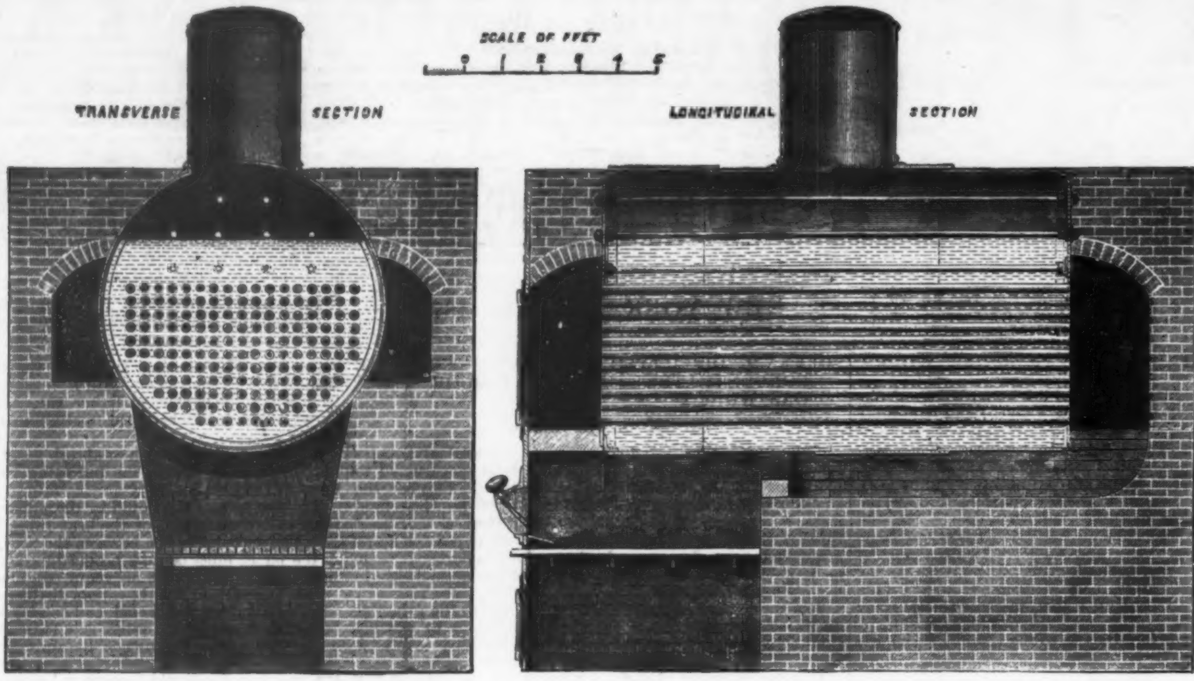
Q is a small washing apparatus for cleansing incondensable gas before it escapes.

It is to be noticed that the float prevents the entrance of any more liquid when the fire is put out, for there is then no product of distillation, the liquid in the condenser remains cold, the float rises and the valve closes, while as the condenser is warmed by distillation the float sinks, and the valve is opened.

The apparatus, as shown in the drawing, is also applicable to the distillation of gas liquor. The product is a concentrated gas liquor of uniform strength, the quantity of ammonia being equal to about 15 per cent. of caustic ammonia. The apparatus employed will distill, in 24 hours, 12, 24, and 48 cubic meters of gas liquor of 2° to 3° Beaumé. A concentrated product is obtained containing 15 per cent of ammonia. The consumption of fuel varies from 25 to 30 kilogrammes of coal for each cubic meter of raw gas liquor.

With very weak gas liquor, the steam of the proportion distilled is utilized to warm the gas liquor as much as possible before entering the apparatus. As gas liquor always contains a variable quantity of solid ammoniacal salts in so-

BOILER ROOM OF THE HAVEMEYER SUGAR WORKS, NEW YORK.



BOILERS OF THE HAVEMEYER SUGAR WORKS, NEW YORK.

lution, a special lime apparatus, to be connected with the still, is requisite to recover the ammonia of these salts. In the distillation, carbonic acid and sulphuretted hydrogen first passes off with ammonia, the water in the still then con taining only a small quantity of caustic ammonia. When this is distilled, the water is mixed with the requisite quantity of lime in the lime apparatus, and immediately redistilled, without in the slightest degree interfering with its continuous working.

To produce ammonia, sulphate, or chloride, it is only necessary to pass the vapor, or the concentrated gas liquor, into sulphuric or hydrochloric acid. The vessel R is then made to warm the liquor to be distilled, by conveying the heated residual liquor from the division B_1, through the worm.

If the apparatus is used for absorbing gas or vapor, the float must be arranged to work reversely in R, as a larger supply of liquid will be required the more rapidly the gas is absorbed, only care should be taken that the liquid never reaches too high a level.

There is no doubt that Solvay's ingenious apparatu iss capable of varied application, and that it forms a real step in advance.

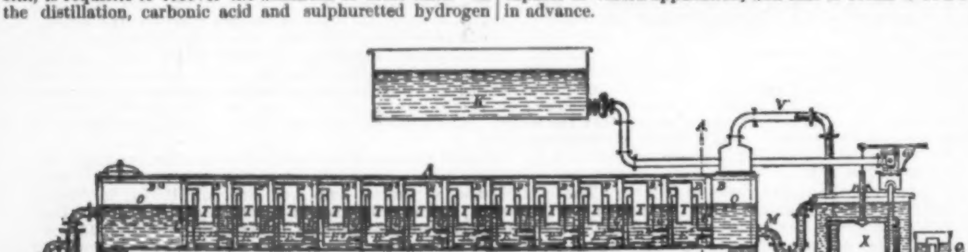


Fig. 1.—Longitudinal Section.

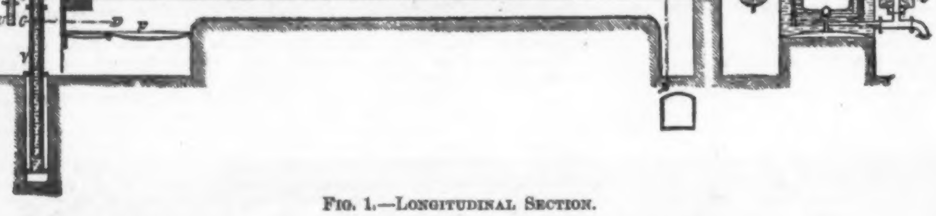


Fig. 2.—Plan on Line C D (Fig. 1).

SOLVAY'S DISTILLING APPARATUS FOR THE CONCENTRATION OF GAS LIQUOR FROM GAS-WORKS.

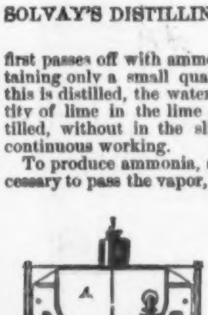


Fig. 3.—End Elevation.

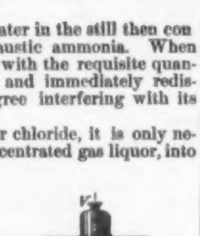
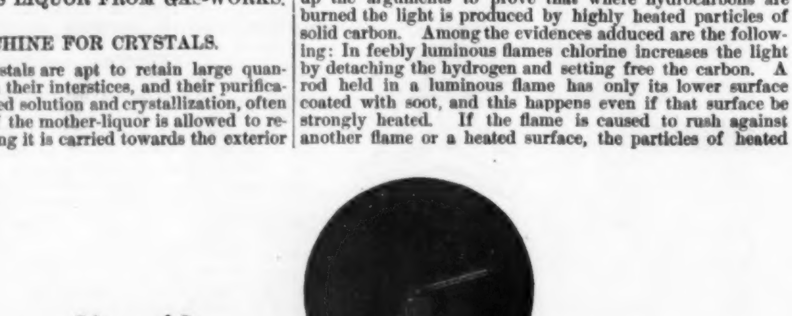


Fig. 4.—Cross Section, Line A B (Fig. 1).

DRYING MACHINE FOR CRYSTALS.

All needle-shaped crystals are apt to retain large quantities of mother-water in their interstices, and their purification, by means of repeated solution and crystallization, often causes serious losses. If the mother-liquor is allowed to remain in the salt, on drying it is carried towards the exterior of the mass by capillary attraction, and often imparts color to it. The removal of this mother-water may be imperfectly accomplished by various means, such as drying upon tiles, upon filtering paper, etc. But in most cases it is necessary to recover the absorbed solution by renewed exhaustion, which only multiplies the processes. Manufacturers on a large scale have long been in the habit of using speciaby constructed centrifugal machines for removing this mother-water, and the construction of these apparatuses as used in sugarhouses, epsom-salt works, etc., are probably known to all of our readers. Less known, however, is perhaps the simple apparatus which we are about to describe, and the illustration of which has been taken from *Mohr's Lehrbuch der Pharm. Technik*. The construction is exceedingly simple and intelligible without detailed description. The spindle at A carries a horizontal board or rotator provided with four upright pieces, the two inner ones of which contain an oblique tapering hole, into which the funnels may be firmly wedged in such a position that the lower sides of the funnels lie in a horizontal line: It is best to use two equally heavy funnels and receivers, exclusively intended for this apparatus. The external uprights are intended merely as supports to the receiver. The cord which transmits the motion from the flywheel to the rotator should not be too thin, and at the same time somewhat elastic. A rubber cord probably answers best.

When using the apparatus, the necks of the funnels are loosely closed with cotton, and enough of the crystals (previously drained by inclining the crystallizing dish) is placed into them. The orifice of the funnels may be covered with paper. Everything being in position, the wheel is set in motion, first gradually, then more rapidly, and after continuing some time, the motion is again gradually diminished. The expelled mother-liquid may now be emptied, and the operation repeated until no more liquid collects in the receivers. The crystals are then removed from the funnels, and exposed to the air for a few hours, when they are ready to be bottled. The funnels are of course again charged, until the whole of the crystals have been desiccated. This is the best method to obtain very pure crystals with the least amount of labor or solvents. The products generally are exceedingly handsome and but very little substance is lost. Mohr recommends the following dimensions as most suitable for pharmaceutical laboratories, calculated for funnels of four inches aperture: Diameter of flywheel 19 inches, small wheels 2 inches, distance between inner uprights of rotator 10 inches.



DRYING MACHINE FOR CRYSTALS.

THE LIGHT OF FLAMES.

Dr. Karl Heumann, on the cause of light in flames, sums up the arguments to prove that where hydrocarbons are burned the light is produced by highly heated particles of solid carbon. Among the evidences adduced are the following: In feebly luminous flames chlorine increases the light by detaching the hydrogen and setting free the carbon. A rod held in a luminous flame has only its lower surface coated with soot, and this happens even if that surface be strongly heated. If the flame is caused to rush against another flame or a heated surface, the particles of heated carbon become visible, as if combined in large grains. The luminous mantle of flame is not wholly transparent. Flames, which undoubtedly owe their light to finely di vided solid matter, cast shadows from sunlight; luminous hydrocarbon flames also cast their own characteristic shadows if interposed in the path of a sunbeam.

[JOURNAL OF GAS LIGHTING.]

PIPES FOR GAS AND OTHER PURPOSES.

(Continued from SUPPLEMENT No. 72.)

MAIN-LAYING.

THE main cutter, made by Messrs. Lambert Brothers, of Walsall, is a useful tool, and answers the purpose of saving a pipe often when its destruction would be objectionable. By its use a cast iron pipe can be cut clean through without risk of irregular fracture. The Fig. 57 of this instrument is sufficiently intelligible without further description.

Obstructions in mains arise from a variety of causes. 1. From defects in the laying. The proper fall may not have been maintained, and, in consequence, an accumulation of water, which should have drained into the syphon-wells, takes place in the slack portion of the line of mains. This is most likely to occur with small pipes laid in level ground. The inspection of each pipe when being jointed may have been neglected, and soil or stones may block the passage of the gas. We knew an instance of a stoppage in a main laid through a field, being caused by a rabbit that had entered the unplugged end of the pipe during the interval of the workmen being absent at a meal. 2. From subsidence in the ground causing the main to bag and fill with water. 3. From a deposit of naphthaline crystals.

FIG. 57.

The means necessary to be adopted for discovering the vicinity of a stoppage or obstruction are exceedingly simple. To an ordinary pressure gauge is fitted a half inch socket. In that portion of the main where the suspected obstacle occurs, a number of holes, to receive each a half inch wrought iron stand-pipe, are drilled at distances of, say, 100 feet apart. In the evening, when the consumption is at its maximum, the gauge is attached to each of the sand-pipes in succession, beginning with the first in the line of mains, and the pressure carefully noted in each instance. Should a sudden diminution in the indicated pressure appear at any pipe, as compared with the previous one, the obstruction exists between the two points; then, in order to further localize it, one or two more stand-pipes may be fixed at intervals less apart. The gauge is applied the second time, and between the points where the falling-off occurs in the pressure the obstruction will be revealed on severing the pipe.

Deposits of naphthaline may be cleared out without severing the main by adopting the method devised by Mr. George Anderson. A pipe from a small portable steam-boiler is inserted through a one inch hole drilled in the main, and the latter is steamed for several hours. The boiler is then fed with a gallon or two of common naphtha, and the vapor coming in contact with the naphthaline crystals rapidly dissolves them, the liquid flowing to the nearest syphon, from which it is afterwards pumped. By allowing the liquid to settle, the naphtha, which will rise to the surface, may be recovered and used over again.

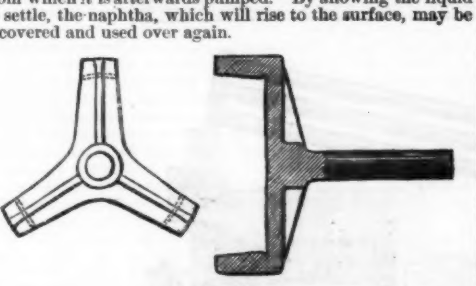


FIG. 58.

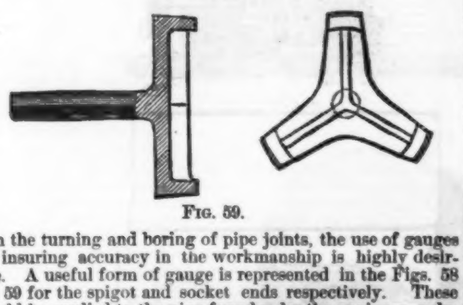


FIG. 59.

In the turning and boring of pipe joints, the use of gauges for insuring accuracy in the workmanship is highly desirable. A useful form of gauge is represented in the Figs. 58 and 59 for the spigot and socket ends respectively. These should be applied to the pipe founder by the engineer, a duplicate set being retained, and every pipe should be rigidly gauged at the foundry before delivery.

In testing the soundness of pipes by hydrostatic pressure during warm weather, the water employed should be equal in temperature to that of the atmosphere. If cold water be used for the purpose, the vapor present in the atmosphere will be condensed on the surface of the metal, and pipes perfectly sound may appear faulty, and be rejected in consequence.

The ordinary length of cast iron pipes is 9 feet. It is not unusual, however, to have them made 12 feet long. There is a manifest advantage in this, and we do not know of any sufficient reason why, for most sizes, the longer length should not be more generally adopted. The number of joints, and the expense of jointing, would thus be reduced about one-fourth. The difficulty of casting them would probably be slightly increased, and this may add to the cost; on the other hand, a proportionate saving would be effected in the extra thickness of metal required for the socket; but any slight difference in the cost would be counterbalanced by the advantages named.

CONTINENTAL RAILWAYS.

A FEATURE of distinct and special interest in the inquiry conducted by the Royal Commission on Railway Accidents is that which relates to the construction and management of continental lines. In order to gain information on this subject the Commissioners dispatched to the Continent a member of the Institution of Civil Engineers, Mr. William Lawford, who made a tour of 3,000 miles through Belgium, France, Germany, and Switzerland, and reported to the Commissioners the result of his investigations. This gentleman put himself in communication with the railway authorities of the several countries he passed through, and spared no pains to give practical value to his inquiry. In addition to the written report and numerous official documents which he laid before the Commissioners, Mr. Lawford gave oral evidence. As the evidence taken by the Commissioners has just been published, constituting a ponderous blue book of more than 1,100 pages, comprising the statements of 334 witnesses, we are now furnished with all the materials on which the Commissioners based their conclusions; and it will be of some public service to see how the matter of railway management stands in a comparison between English and foreign lines.

Taking Mr. Lawford's evidence in the order of his report, we commence with the subject of railway stations. Here, however, beyond some technical points, there is little said. The terminal stations abroad are pretty much as they are in England. Some of them are "palatial, and covered in by elegant single-span roofs of large size." Perhaps we may pause here, and express a regret that Mr. Lawford has not specified the source of the "elegance" to which he refers, for the "single-span roofs of large size" which characterize terminal stations on this side the Channel are not, as a rule, praised for their beauty.

Passing from the general question of station construction to that of railway platforms, we find Mr. Lawford referring to the fact that the continental platform is invariably low—that is to say, of a height varying from 4 inches to 15 inches. The latter is about the height of the platforms of the Rugby Station of the London and Northwestern Railway. Certain advantages are claimed by some parties as appertaining to the low platform. Thus it is alleged that the low platform affords peculiar facility for the moving of passengers, and of luggage, lamps, trucks and stores about the station, the railway under such circumstances being in reality one continuous level crossing. It is also claimed that the low platform practically abolishes the perilous chasm which exists between a train and a high platform. On the other hand, the high platform is safer than the low in respect to the risk of stumbling and falling when getting in or out of a carriage when the train is at rest. With a low platform the passenger has further to fall, and perhaps if the platform were high he would avoid all mishap, being able to step from the carriage to the platform, or *vice versa*, almost on a level. For the aged and infirm low platforms are obviously inconvenient, while to the agile and impetuous there is perhaps greater safety in the low platform than the high one. If by the use of the continuous footboard and a proper adaptation of levels as between the carriage and the platform the danger of falling between the platform and the train could be got rid of, a serious disadvantage now attendant on the use of the high platform would no longer exist. A lesser question is that which affects passengers' luggage, Mr. Lawford observing that such luggage is exposed to exceptionally bad usage where low platforms prevail.

The same witness states that the passenger carriage in use on the Continent is practically identical with that which is generally adopted in England. Exceptions occur in Switzerland, and on one or two of the German lines, where a carriage of extreme length, and resting on two bogie frames, is in use. In trains composed of these carriages the guard can pass from end to end of the train without personal risk. There are no side doors to interfere when open with the current of traffic on the railways; and these carriages are specially adapted for passing round sharp curves, owing to the shortness of the wheel-base appertaining to the bogies. Two-storied carriages are also in use on some of the German lines, and elsewhere. The system of communication by cord between passengers and guard does not exist on the Continent, except partially in Germany. In Belgium and France, however, the cord communication is invariably found as between the driver and the chief guard. The want of such communication for the passengers is generally atoned for by the arrangement which enables the guard in most instances to pass from carriage to carriage by means of a footboard, along which he walks while holding on to bars attached to the carriages. This train gangway is fraught with danger to these unfortunate men. The Belgian list of accidents enumerates 25 death casualties per annum from this cause alone. The equivalent in England, in proportion, would be a loss of 222 guards per annum—enough of itself to justify a Royal Commission, according to British ideas. In respect to speed, the average rate of continental trains, except a few of the express trains in France, would be called moderate in England. Among minor matters, Mr. Lawford mentions that at Dusseldorf he observed certain compartments of carriages reserved exclusively for ladies, and painted of a bright yellow color, resembling that of the old-fashioned post-chaise in England. The very general reservation of certain carriages for "non-smokers" is also noticed, achieving a purpose which is attained in this country by an exactly opposite method. At the Malines Station Mr. Lawford observed a curious and novel angular arrangement of mirrors, placed in the guard's observatory which projects above the top of the break van, and by means of which the guard could see both ends of the train at once, besides being able to see the railway in both directions. It is noticed that an intelligent man might find this appliance very useful. Respecting the locomotive, the practice of giving the engine-men protection from the weather by means of what is called the "cab" is not adopted in Belgium, but is universal in Germany. In France it is only partial. In Belgium a screen is used, and we are told that "neither cab nor screen is anywhere considered to interfere with driver's knowledge of the working condition of his engine." Whether such protection—seemingly so desirable for the sake of the men—is likely to interfere with the due discernment of signals and obstructions on the line we are not told.

The continuous break is in very partial use on the Continent. The chief feature in regard to signals is said to be their extreme simplicity, the disk signal placed on the top of a post ten to sixteen feet high being the usual appliance, one side of the disk being red and the other white. At night, of course, lamps are used. The semaphore is employed at bifurcations. There are certain cases in which three signals are adopted, involving at night the use of red, green, and white lamps. In Germany the green color means "caution," but in Belgium it signifies "line clear," and is only applied to the semaphores to distinguish them from the disk signal lights, in which the white color means "line clear." We should presume from this that the Belgian lines have no "caution" light. Some diversity in the system of signalling is not unknown in England, and is made the subject of remark by the Commissioners, who urge the importance of a uniform code for all the lines. The block system has been only partially introduced on the Continent. Germany has this system at work on several lines, and Belgium only on one; but in the latter country it is considered indispensable, and its general introduction is reckoned upon at an early date.

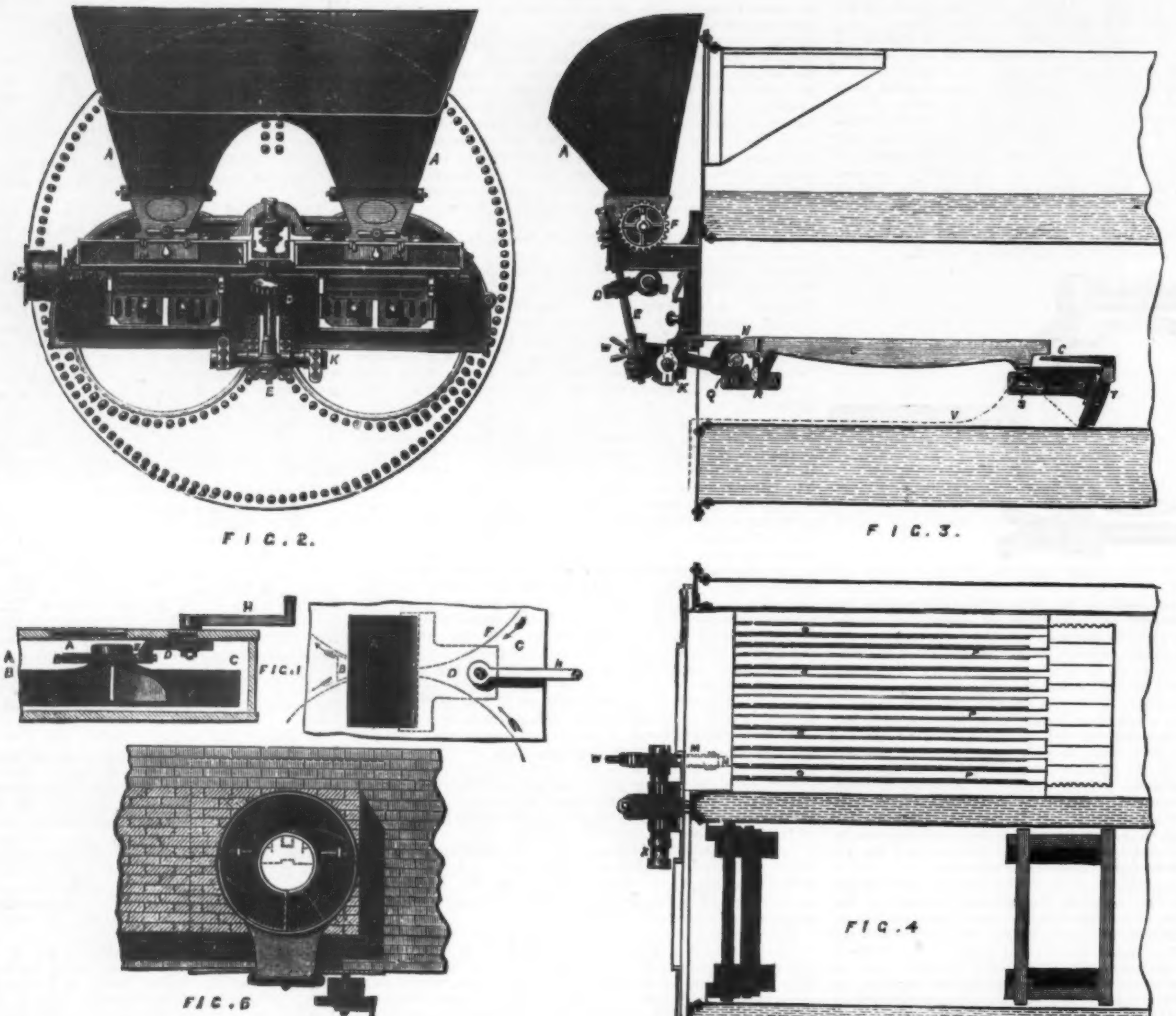
Level crossings of all kinds are very common on continental lines. Railways are crossed on the level by other railways, by street tramways, and by roads. Concerning the accidents to foot passengers at these points, Mr. Lawford obtained some rather conflicting evidence, the watchman stating that accidents were extremely rare, while one of the Belgian engineers stated that from 200 to 300 deaths per annum occurred at these critical places in Belgium alone.

The hours of work on foreign lines are much the same as in England. But it seems as if the practice of employing some men only eight hours a day were more prevalent on the Continent than it is here. On this point we find Captain Tyler stating before the Commissioners that, according to the testimony of some of the English superintendents, men have not worked so well when their hours of work have been reduced from twelve to eight. The remedy appears to consists in distributing the eight hours over a series of twelve, the evil being that the men do not always rightly use their leisure, the companies having no control over them when they are off duty. At the same time Captain Tyler admits the danger of having men at work for excessively long hours, and accidents have been distinctly traceable to this cause. Another question of discipline is that which relates to the practice of taking gratuities. On the Continent, as in England, this practice "is everywhere prohibited," and is "everywhere admitted to exist."

In Belgium each passenger is allowed to carry 55 pounds weight of luggage of any description. The allowance is the same in Germany. In France it is 66 pounds, and in that country the quantity of passengers' luggage carried is increasing, although this is said not to be the case in Germany and Belgium. The luggage is invariably carried in luggage vans. An English witness, Mr. T. Humphries, the station-master at Bletchley, stated to the Commissioners that passengers generally carried more than the specified weight of luggage, and this was particularly the case with first-class passengers. A troublesome novelty was also showing itself, in the shape of "large American trunks," requiring two men to lift them, and occupying an extra minute of time.

In giving his evidence before the Commissioners, Mr. Lawford made some statements supplementary to his report. Thus he specified that in Germany, particularly in Prussia, there were very few railways crossing railways on the level, and for some time past those that do exist have been undergoing alteration by bridges where practicable. In reference to the superior punctuality of the continental railways as compared with the English, Mr. Lawford underwent some close questioning by the Commissioners as to the apparent cause. The explanation was sufficiently given by the fact of the traffic on the English lines being so much more crowded and complicated, though the witness seemed inclined to think that the slower rate of traveling on the continental lines was favorable to the punctuality of the trains. On this point it was urged by Mr. Harrison and Mr. Galt that the fastest trains in England kept the best time. Still the witness seemed to hold to the view that the English trains required longer time for their work, and that a revision of the time tables was in some cases necessary, so that the companies should only undertake that which they could really perform. Mr. Ayrton indicated his own notion on the subject by asking:—"If you go in your own carriage from Hyde Park Corner to Aldgate Pump, is it not an even chance whether you will or will not lose one-fifth of your time as regards punctuality?" Mr. Ayrton also made distinct reference to the "great variety of traffic" in the streets of London, as a source of embarrassment to the private carriage which is driven with a regard to punctuality. It seems that, although the fastest trains are the most punctual, the unpunctuality observable on some of the English lines is not proportioned so much to the mere crowding as to the intermixing of trains traveling at different rates of speed, and the complications of the traffic consequent on the numerous junctions. The latter cause has its effect on the Continent. Thus, Mr. Lawford says in respect to the French and other continental lines: "The trains were tolerably punctual throughout my journey. In only one case, I think, were they a quarter of an hour or twenty minutes behind, and that was not the fault of the train I was traveling in, but of another train which was delayed at a junction and was late." Captain Tyler spoke of the Metropolitan Railway—an example of a thoroughly crowded line, for which Mr. Lawford found no parallel abroad—as working very regularly, though a Great Western train might come on late from Paddington. As for speed on the English lines, Captain Tyler believed we should get to something higher still, but all depended on the character of the permanent way.

There is a deficiency of statistics in respect to continental lines which makes it difficult to estimate their safety in comparison with English railways. A curious rule prevails in Germany, that if a person is injured on a railway and subsequently dies from the injuries received, the occurrence is not deemed a railway accident unless death occurs within 24 hours. It is somewhat remarkable that on the Continent, where Government supervision is expected to be stricter and more detailed than in England, the number of railway passengers is not recorded. Hence the percentage of passengers killed and injured cannot be ascertained. Altogether, a comparison between English and continental lines is singularly barren of any result which can suggest an improvement at home. After his extended tour, and all the researches he has been able to make, Mr. Lawford admits his inability to recommend any change of system on English lines according to a continental model. He evidently considers that any schemes of improvement set in a direction from our shores and not towards them, the foreigner having to learn of us, and not we of him. In some few details it may be otherwise, but it is remarkable how completely our railway directors and engineers seem to have covered the ground; and we can only gather from Mr Lawford's report and evidence that, as compared with the countries which he visited for the purposes of this inquiry, England is decidedly in advance on the subject of railway construction and management.—*Engineering and Building Times.*



THE HENDERSON MECHANICAL STOKER.

ON THE MECHANICAL FIRING OF STEAM BOILERS.*

By Mr. W. J. PEARSE.

THE many disadvantages of hand-stoking, even when performed by a careful and experienced man, are only too apparent. The supply is intermittent, and therefore irregular. However evenly and lightly the coal may be distributed, combustion must be imperfect, and must therefore favor the escape up the stack of unconsumed gases. The opening of the fire-hole door admits a volume of cold air on to the top of the fire, which not only increases the last-named evil, but also further creates waste by lowering the temperature of the flue. In addition to this, the hard physical labor of firing has to be performed under exposure to the direct heat of the furnace. If approximately regular firing is difficult to insure on land, it becomes still more difficult on board ship, especially during heavy weather, when keeping steam is perhaps of the utmost importance.

The advisability of superceding uncertain and irregular manual firing by a continuous feed, effected by mechanical means, was felt at the beginning of the present century; or, at any rate, this appears to have been the period when projects for mechanical stoking first assumed a practical form. Reference to the latter portion of a paper "On the Use of Coal in Furnaces without Smoke," read before the Society on the 12th of May, 1862, by Mr. Charles F. T. Young, will show that brains were busied as early as the year 1813 in endeavoring to solve this important problem; and a search into the records of the Patent Office affords evidence that many patents were obtained for accomplishing this object in one form or another, even if that form were somewhat clumsy when compared with the more perfect machines in use at the present day.

The author of the present paper does not attempt to trace the history of mechanical stoking from the beginning of the century until now, but will only describe such appliances as have attained a certain amount of practical application, dwelling at greater length on those stokers which are at present doing good service in lessening the consumption of fuel, preventing smoke, and substituting power for manual labor in a field where such a change is highly desirable. In most of the appliances, some automatic arrangement for stirring the fire, cleansing the bars, and removing the ashes and clinker, accompanies that for the supply of fuel. Indeed, the two go hand in hand together; for it is evident that but half the desired advantage is obtained if, while a man is saved from the labor of throwing coal on the fire-grate, he is still exposed to the fierce heat while raking the bars, and if the fire-door, kept carefully closed against the admission of a supply, be opened for the discharge of the waste matter, with all the attendant evil of the in-rush of cold air.

In the year 1822 Mr. John Stanley invented a stoker with a pair of fluted horizontal rollers for crushing the coal as it descended from a hopper in front of the boiler, at the same time equalizing the supply. Below the rollers was fixed a three-armed fan, revolving on a horizontal axis, for projecting the coal into the furnace. In 1834, Mr. Stanley, with the co-operation of Mr. John Walmsley, substituted indented rollers for fluted, and made his fan to revolve on a vertical instead of a horizontal axis. He also arranged the fire bars so as to rock by means of gear connected with the stoker, and caused the steam in the boiler to act on a float in a syphon tube for stopping the feed when a certain pressure was attained. In 1838 Mr. John Juckes patented an arrangement of screw rams, by which successive charges of fuel were forced into the tubes, where the coal was distilled before being discharged into the furnace. In 1839 he devised a narrow movable platform in the middle of the fire-bars, and hinged at the back end. On a fresh charge being propelled by a plunger on to this platform, it was forced up on a level with the fire-bars, both actions being performed by levers. In 1841 Mr. Juckes patented the invention with which his name is more particularly associated—viz., an endless chain of fire-bars, supported at each end by rollers, which are carried on trucks. As the chain passes under the boiler, it draws from a hopper its supply of coal, which is regulated by a door sliding vertically. In the next year Mr. Juckes somewhat modified this idea in the construction of his circular grate, made to revolve by means of a rack fixed to the circumference, and actuated by a pinion. A portion of the grate is always outside the furnace, when the bars, which are pivoted at one end, fall down in succession to allow of the disengagement of clinker, and are then raised again before entering the furnace. The fuel is drawn along much in the same way as in the previous arrangement.

In 1863 Messrs. Wilson and Smith caused their fire-bars, which were of the ordinary shape, or nearly so, to travel backwards from the front of the furnace, so as to carry towards the bridge the fuel fed from a hopper provided with a regulating damper; the bars then moved backwards, either singly or in pairs, the motions being given by two drums, fitted with projecting arms, placed underneath the bars at the front end, and driven by any suitable means.

In 1867, Mr. Thomas Vicars, Mr. Thomas Vicars, Jr., and the same Mr. Smith, patented some improvements on the preceding invention. Between the Wilson and Smith fire-bars they placed others of shorter length moving backwards and forwards to a less extent than the travel of the former, from which they received motion. Again, instead of passing all the fuel from the front end under the furnace door, they supplied the whole or part of it from a hopper, situated at a higher level, and from which tubes descended to the grate. In some cases, part of the supply was led by a tube through the boiler itself, so as to deliver about midway between the front end and the bridge.

In 1870 Mr. Dillwyn Smith filed his specification. In the stoker associated with his name the coal is allowed to fall from a hopper in front of the boiler into a horizontal cylindrical receptacle, in which works a helical screw for giving the feed. In the case of a double-flued boiler, the screw is made right and left handed, the middle being placed just under the centre of the hopper; and from the middle the diameter of the screw gradually increases until, at the ends, it becomes almost as large as that of the casing. At the ends of the screw shaft, and outside the screw, are projections for more evenly distributing the coal as delivered by the screw. The pieces of coal are caught in falling by the vanes of a pair of fans, revolving towards each other in a horizontal plane, and are by them projected on to the furnace. As the pieces which are struck by the ends of the vanes are projected furthest into the furnace for a given size, and as the size of the pieces varies, it follows that an even distribution of fuel is effected over the whole area. The fan shafts are driven by belts from a separate vertical shaft, actuated by a donkey engine or any available power; and the shaft of the feed screw is driven by a worm and worm wheel put in motion by another vertical shaft worked by a strap off one of the fan-shafts, a pair of cone pulleys and a rod and lever serving to change the speed as may be required. A large number of stokers have been made on this plan, and many are still at work, giving admirable results as regards the saving of fuel. Mr. Dillwyn Smith also included in his patent an arrangement of two separate fire-grates in one flue, with argand fire-bars in the centre, so contrived that the gases distilled from the coal on the former are burnt with perfect combustion by the heated air proceeding from the latter. The grate-bars are placed across the flue, and are made to move from time to time by the turning of an octagonal shaft on which they rest.

In the same year—1870—some improvements on the Dillwyn Smith stoker were made by Mr. George Frederick Deacon. It sometimes happened that, when large coal was used, some of the pieces were not sufficiently reduced by the screw in one of their rectangular directions. To obviate this, a second but smaller thread was introduced between the main thread, and, like it, gradually increasing in size. It was also found that coal dust sometimes accumulated between the disk of the fan and the bottom of the casing; this was counteracted by casting a narrow spiral feather on the bottom of the disk, and making some holes to admit the air, so that a sufficient draft was created to prevent the accumulation. At the same time, the fan shafts were reduced in height, chiefly for lessening the friction of the lower foot-step, which for this reason, as well as on account of the conducted heat from the furnaces, it was sometimes found difficult to keep cool. A non-conducting substance was also introduced between the foot-step and the underside of the fan-case. One of the fan-shafts was, however, retained at its former height to serve for driving the others, the pulleys of which were kept as near the fans as the screw casing permitted. Each of the shafts had two bearings in a single bracket above the fan; and the step was sometimes dispensed with altogether by forming a collar on the upper ends of the shafts. Subsequently, the fan-shafts were driven by toothed or friction wheels, inclosed in a chamber immediately below the fan-case, thus dispensing with all but one belt, because they were found to be deteriorated by the heat of the fire if the machine was kept standing for any length of time. Perhaps the most important addition made by Mr. Deacon was his deflector for causing all the particles of fuel delivered by the screw to fall upon the fans. This consists of two castings bolted together, shown both in elevation and plan at Fig. 1, where A is the aperture through which the fuel falls, and F F the two fans. The particles are prevented from falling between the fans on the hinder side of their centre line by the inclined edge E of the plate D, and at the front side by the part B, which has a triangular section and curved base. The handle H, the stud of which passes through the slot S in the fan casing C, allows the deflector to be moved both inwards and outwards as well as in a radial direction, until that position is found in which the most uniform delivery is secured.

THE HENDERSON STOKER.

The Henderson stoker, which incorporated Mr. Deacon's additions, contains still further improvements on that invented by Mr. Dillwyn Smith; and the two interests are now merged in the Mechanical Stoker Company. Additions and modifications were patented by Mr. Thomas Henderson in 1872, 1874, 1875, and so late as the end of last year. Instead, however, of following these successive changes one by one, it will perhaps be better to describe the Henderson stoker as it now exists with the latest improvements introduced.

Fig. 2 shows a front elevation of the stoker as applied to a Lancashire boiler; Fig. 3 is a side view, partly in section; and Fig. 4 is a horizontal section, showing the fire-bars. The coal contained in the hopper A is fed down the two divisions, one in front of each flue, by means of a roller, which is modified in form according as it has to crush coal, or merely regulate the supply of slack. The particles are caught as they fall by the arms of two fans contained in the fan-case C, revolving towards each other in a horizontal plane, and are by them projected into the furnace, being distributed equally over the whole surface as in the Dillwyn Smith arrangement. The great improvement consists in the compact arrangement of parts, and the direct manner in which they are driven. Thus, a horizontal shaft B made to revolve by a belt and pulleys, or in any other convenient manner, is carried by bearings immediately under the fan-case, and, by means of a worm in the centre, turns a worm-wheel D on a nearly vertical shaft E. This shaft carries a worm at its upper end which gears with a worm-wheel F keyed on the feed shaft, while it has another worm at its lower end for moving the fire-bars. The fans are driven direct by friction pulleys G G, on the horizontal shaft, working against a ring of leather, for preventing rattle, fixed to their hollow underside. The fans, therefore, revolve at the rate they are speeded—about 200 a minute—but the feed is regulated by turning the hand screws I I, which push in or draw out the front plate of the hopper, which is provided, if necessary, with an indented steel plate for facilitating the crushing of the coal. Sight holes are made in the fan-cases for affording means to ascertain that the fans are properly working; and part of the bottom plate of the fan case is constructed so as to be easily removable for taking out a fan in case of need. Sliding ventilators, for regulating the admission of air, are also provided in the furnace doors, as shown in the front elevation. The two outside fire bars remain stationary, but the others have a motion imparted to them by the crank of the short horizontal shaft K, links M, and projecting or connecting bar N. Every other fire-bar, O O, slides on the roller, Q, while the rest, P P, carried on the rocker R, and cross-bearer S, are, owing to the cranked shape of the rocker, made to rise and fall. The ashes and clinker are thus carried in one direction, according to the setting of the cranks. In the arrangement shown in Figs. 3 and 4 they are carried to the back end of the flue, on to a kind of dead plate formed by the ends of the lifting bars, which are continued beyond the sliding bars; they gradually fall into the ashpit at the back, whence they are removed periodically by means of the hanging door T, worked by the chain V, from the front of the boiler. In this way, as the supply of fuel is automatic and continuous, so is there also an automatic stirring of the fire and cleansing of the fire-bars continually going on. The amount of rise and travel of the bars is regulated by turning the hand screw W, according to the nature of the fuel and the demand on the boiler. At the same time this double action of each alternate bar lifting and sliding keeps the interstices between them clear for the free admission of the air necessary for combustion.

All the foregoing mechanical arrangements for supplying fuel to furnaces appear to have been designed in imitation of the supposed perfection of hand stoking—that is, the even distribution of a thin layer of coal over the whole surface of the fire, and as lightly as possible, so as to admit plenty of air for effecting the combustion. In the Frisbie feeder, however, a different principle has been adopted—that advocated by Dr. Arnott for domestic fireplaces. This consists in a supply of fresh fuel being given from below, which, on being subjected to the heat of the incandescent mass above, evolves its gas to be consumed on rising through the fire. The other arrangements are for quick combustion, this one is for slow combustion. In those the feed is continuous, while in this it is intermittent; but the evil of admitting a volume of cold air on the top of the fire is avoided in this case as in the others. In 1868, Mr. Myron Frisbie, of New York, without claiming to originate the idea of feeding fuel from below, patented an arrangement whereby coal was thrust up underneath, and in the middle of the fire, and several of his machines are still at work, doing very good service. In 1875, Mr. James Millward Holmes and Mr. Walker, of Birmingham, introduced into this feeder some improvements, which chiefly consist in substituting gear for the direct action of a lever, while at the same time the whole machine is simplified.

Fig. 5 is an elevation of the improved Frisbie feeder as applied to a Cornish boiler; Fig. 6 is a plan of the firegrate; Fig. 7 a vertical section, showing the fuel-box in the position for receiving a supply of coal; and Fig. 8 shows the position it assumes while the charge is being thrust into the furnace from below. In this latter view the feeder is shown applied to a Root's tubular boiler. In place of the usual straight fire-bars is a central circular aperture surrounded by segmental gratings (shown best in the plan, Fig. 6), which are easily removable, while the whole annular arrangement of grate runs on friction rollers like a turntable, and may be moved round by means of a crowbar inserted in the holes shown at Fig. 5. Underneath the central aperture is the cylindrical fuel box, A, mounted on forked side frames, B B, which swing on pivots, F F, attached to the base plate along the center line of the fuel box. Cast in one with this fuel box is the apron, B, for retaining the coal when the box is in its inclined position ready for being filled; and jointed to it is the lever D, by the intervention of which the rod, E, attached to the movable bottom of the fuel box, is raised by the crank of the shaft, to be afterwards described. A, B, C, D, and E swing together on the pivots, F F; but the movable bottom of A is at the same time capable of rising and falling, being retained in its highest position by the catch, G, engaging with the nose of the lever, D. The crank of the shaft, H, mounted on bearings, also arranged along the central line of the fuel box, carries a friction roller, I, which acts in its rotation upon the lever, D, and consequently raises the movable bottom of the box. This shaft has also another pair of arms, J J, provided with pins which take into notches in the links, K K, jointed to the forked plates, B B, and thus alter their position from inclined to vertical, and *vice versa*. The shaft is moved by the bevel gear and winch, either direct in a small machine, or with spur wheel and pinion in a larger one, as shown in the vertical sections. Assuming that the fuel box is filled with coal in its inclined position, the winch is turned so as to move the crank shaft in the direction of the arrows in Fig. 7. The arms, J J, by means of the links, K K, draw the forked plates and fuel box underneath the central aperture, when the links rest upon the shaft, locking the box in its vertical position. As the crank continues to revolve in the same direction, the pins leave the notches in the links; and the friction roller, I, comes into contact with the lever, D, and raises the movable bottom of the fuel box, thus forcing the coal upwards into the fire. The bottom is held in this position by the nose of the lever, D, engaging with the catch, G. The winch is now turned the reverse way, which causes the shaft to revolve in the direction shown by the arrows in Fig. 8. The pins again engage in the links, K K, thus pulling over into an inclined position the forked plates and fuel box, which latter is followed up by the apron, C, for the purpose of retaining the coal in the firegrate. As soon as the catch, G, strikes the bar, L, it releases the lever, D, and thus allows the movable bottom to fall to its first position, ready for another charge of fuel. Each fresh charge displaces that previously inserted, and so has the effect of moving the whole fire. This action breaks up the cinder, and gradually carries any hard clinker that may have formed to the circumference of the grate, where it is removed at intervals by bringing in succession each part of the segmental gratings before the furnace door by means of a crowbar.

It is evident that this arrangement is not applicable to the flues of Cornish or Lancashire boilers, as they are usually fired; but the Frisbie feeder has been applied with success to these boilers, either in the middle of their length, as shown in Fig. 5, or at one end, in a kind of combustion chamber made of firebrick, communicating direct with the internal flue. There also seems now to be a reaction in some quarters in favor of externally fired boilers, especially that class in which two or more large horizontal water tubes are connected by smaller vertical tubes, as shown with Frisbie feeder attached, in sketch, Fig. 8A.

The "Helix" fire feeder, devised by Mr. Holroyd Smith, appears to combine, in a modified form, the two principles before mentioned—that is to say, the fuel is fed from below, while at the same time the feed is continuous. Its application differs from that of the Frisbie feeder in its being more suitable for an internally fired boiler, for which, in fact, it was specially designed. In this appliance two or more of the ordinary straight fire bars were replaced by a trough, in communication, at the bottom, with a tapering case of cylindrical section, in which works an Archimedean screw of modified form. The fuel contained in a hopper, placed in front of the boiler, is thus absolutely screwed into the fire underneath the incandescent coal, so that the gas is extracted by the heat, and burnt as evolved. The air necessary for combustion makes its way between the interstices of the bars, which are serrated on their upper edges for facilitating its distribution through the fire.

Fig. 9 shows a front view of a Cornish boiler fitted with this arrangement, part of which is in section; and Fig. 10 shows a longitudinal section of the boiler, with the "Helix" partly in section and partly in elevation. The hopper, H, is in communication with the feed trough, F, which is placed across the front of the flue, and communicates in turn with two or more screw cases, according to the size of the boiler. In the diagrams, three of these cases are shown, containing the screws, S S S. As this screw is of uniform pitch but of gradually decreasing diameter, suitably calculated, it delivers the fuel evenly throughout the whole length of the fire bars, B B; and the coal must be forced upwards through the longitudinal aperture, as that is the only outlet. Any large lumps of coal are crushed by the screw before being passed on. The cinders fall over the brick fire bridge, and are removed once a day by withdrawing the damper, D. A is an ordinary fire door for the inspection of the fire, for banking

* A paper recently read before the Society of Engineers, London.

it up, or for use in hand firing, in case of a breakdown to the engine driving the feed gear or from any other cause. The screws were originally made to revolve by means of ratchet wheels and pawls, attached to a bar caused to oscillate by means of a crank and lever. Subsequently, however, the arrangements shown in the diagrams has been adopted as being more compact—that is to say, worm wheels on the axis of the screws are turned by worms on a horizontal shaft running in front of them, and driven by a belt. In the apparatus the author saw working, at Halifax, a small engine, of a single man power, is found sufficient to work two machines fitted to Cornish boilers driving 100 horse power. Any obstruction to the feed, through any extraneous substance becoming mixed with the fuel, instead of causing any breakage, merely pulls up the engine. By disconnecting the lever the feed can even be worked by hand.

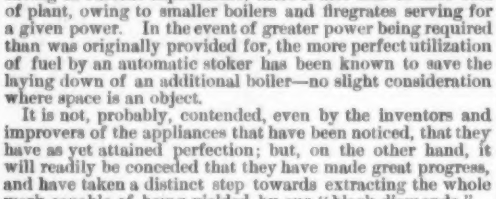
In the foregoing remarks, examples have been given of appliances for automatically supplying fuel to both internally and externally fired boilers, with both quick and slow combustion. In all of those of late date, which have been more particularly described, a great saving in coal has been effected. The author has purposely avoided any bare statements as to an economy of so much per cent., or an evaporation of so many pounds of water per pound of coal; for all such statements must be taken in connection with the nature of the fuel and the various attendant circumstances. It may be remarked, however, that the saving is twofold—first, in quality, as a cheaper or smaller coal, when properly burnt, will do the same work as larger coal subjected to imperfect combustion; and secondly, in quantity, as, for a given power, the whole, or nearly so, of the useful effect of the fuel is turned to account, instead of a large proportion going up the stack to worse than waste. Again, in addition to this saving in current expenditure, there is also that in first cost of plant, owing to smaller boilers and firegrates serving for a given power. In the event of greater power being required than was originally provided for, the more perfect utilization of fuel by an automatic stoker has been known to save the laying down of an additional boiler—no slight consideration where space is an object.

It is not, probably, contended, even by the inventors and improvers of the appliances that have been noticed, that they have as yet attained perfection; but, on the other hand, it will readily be conceded that they have made great progress, and have taken a distinct step towards extracting the whole work capable of being yielded by our "black diamonds."—*Engineer.*

WATER WORKS AT BANGOR, MAINE.

By L. H. Eaton, C.E., Engineer Bangor Water Board.

These works are situated one and one-half miles from the post-office in Bangor, and are upon the plan of direct force, known as the Holly system. There are four piston pumps, of 12 inches diameter of cylinder and 27 inches stroke, mounted at the four corners of the base of a heavy cast-iron frame and connected to a crank shaft above. The shaft is carried in boxes on the upper arched portions of the frame, and the two pumps on each side transverse to the shaft are connected to the same crank pin, the piston rods making an angle of 45° with the vertical; the two crank pins, at opposite ends of the shaft are so disposed that the pumps take suction and discharge at eight equidistant points for each revolution, securing a uniform flow into the main. Either pump may be disconnected so that one or more may be run at any one time. These are supplemented by an elliptical rotary pump of the capacity of sixteen gallons per revolution; the whole set is capable of easily supplying five million gallons in twenty-four hours.



The pumps are driven by three American turbine wheels, made by Stout, Mills & Temple, Dayton, Ohio, eighty-four inches in diameter, working under a varying head of from five to fourteen feet, according to the rise and fall of the tide. Thus far it has only been found necessary to use two of these wheels at once, and then with a gateage of one-fourth to one-half their capacity, according to the tide, even in case of the largest fire experienced since the construction of the works. In addition, the works contain a compound steam engine, built by the Holly Manufacturing Company, the high pressure cylinder being fourteen inches diameter with a piston travel of 24 inches, and the low pressure cylinder being 21 inches diameter and 30 inches stroke. They may both be worked at high pressure when necessary.

This engine is supplied by steam by two horizontal tubular boilers of 5 feet diameter and 15 feet long, each having 54 three inch tubes, and set in a room adjoining the engine and pump room, with a smokestack outside 70 feet high. The boiler room is 39 by 40 feet, the pump and engine room is 50 feet square, and the wheel house adjoining the pump room, on the end opposite the boiler house, is 39 by 44 feet over the machinery floor, of which a tenement is finished off for the residence of the engineer.

Water is received into the wheel pit from the head race through two arches of 190 square feet area, causing the current into the wheels to be very slight, and passes from the pit into the tail race through arches of 150 feet area. The current from the wheels is very much more rapid as the tail race descends rapidly. These arches are so arranged that the water will at all times cover the entire intrados, thus excluding the cold air and preventing ice forming in the wheel house or flume. The outer or coarse rack is so arranged that it is entirely below the surface of the water in the pond, thus allowing drifting substances to pass over the dam. The fine rack is so situated that anything that passes the outer rack and the head gates draws by it and passes through the waste way of the flume into the river below; this waste way is intended also to provide for any excess of water that may pass the head gates. The gates in the wheel cases are controlled by one of Holly's automatic governors, which, by means of belts and gearing, opens them when the pressure is diminishing in the pipes, and shuts them when the pressure is increasing, a very ingenious piece of mechanism and admirable in its operation.

The pressure in the pipes is governed by a safety valve leading from the force main, which valve may be weighted to whatever pressure may be needed. For instance, the domestic pressure is 110 pounds; if five pressures is needed on high service, say 230 feet above the works (our highest service), the engineer has simply to weigh the safety valve to its proper requirement, and, setting the indicator of the governor at the required pressure, it at once runs up. If the movement be too slow to meet the need for an immediately increased supply of water, it can be expedited by the engineer turning the governor by hand.

Communication is had with the works by means of telegraphic gongs, that the engineer may be informed of any want of increased quantity of water for fire or other purposes.

The water flows from the flume to the filter through a revolving screen of copper wire netting, which catches and passes off into the wheel-pit any sawdust or other small substances that may be held in the water. The filter is of two chambers, each 12½ feet wide by 150 feet long. From these the water passes into a filtered water chamber, from which the suction pipes take it to the pumps. The filter bed is composed of brick, gravel, and sand, and yields sufficient water to supply the demand of the largest fires. The buildings are heated by steam; therefore, as our boiler is always fired up in winter, if the wheels become clogged with anchor ice, or an accident happens to them, immediate resort may be had to steam power.

The system of mains comprises 21½ miles of pipe—cast iron, tar coated—the force main is 16 inches in diameter, and extends from the works one mile into the city, at which point it is reduced to 12 inches, having, before reaching that point, been relieved by numerous secondary mains. The distance from the works to the end of the most remote pipe is about 2½ miles. There have been set 146 hydrants, principally of the Holly pattern—a few Matthew's hydrants are in use.

The dam for the water power is at a locality known as Treat's Falls, 1½ miles from the post-office; these falls were simply rapids with a natural descent of about 22 inches. The tide has here a mean rise and fall of about 12 feet. The crest of the dam is 8 feet above mean high tide, and has an overfall 900 feet in length between abutments; the river bottom is of slate ledge, irregular in its contours, with a trend crossing the direction of flow of the river at an angle of about 45°. The dam is of crib work filled with stone. Into the irregularities of the ledge timbers were fitted until the work was brought up to a height to admit of the regular crib work being fitted upon it, the entire structure was thoroughly bolted together with seven-eighths iron bolts, and solidly packed with rubble, common field stone, and stone from the river shores; it was then covered with 6-inch hemlock plank, the toe filled and covered to a depth of from 8 to 10 feet with gravel and stone. The accompanying sketch will give the form of the dam and an idea of its structure.

The dam was commenced at each end and extended into the river by placing tier after tier of logs from the bottom up, until the water at low tide was too deep to permit men to place the logs. The remaining gap, of some 300 feet, was then carefully sounded out at very frequent intervals, cross-sections of the lock bottom thus obtained, and cribs were built to fit the same. These cribs were as long as the breadth of the dam, some 15 or 20 feet wide, and came a little above low water level when sunk. They were successively floated to place at high tide, moored in position, adjoining the portion already partly built, and sunk by loading with stone. Jogs or shoulders on the faces in contact kept the sinking crib in line, while strong tackle drew it firmly against the end of the dam. On the receding of the tide it was filled completely with stone. The entire gap was thus filled with cribs, which came above the low water line on the lower side of the dam. A coffer dam or temporary construction was formed, to stop the flow of water over this portion and to cause it to run over the completed part. As the cribs were built hemlock posts 12″ x 14″, set 8 feet from center to center, and about 6 feet from the toe or upstream line of the base of the dam, were framed in vertically, in some cases being permanently fastened, and in others being fitted into deep sockets and then removed, to be put in when the dam was so far finished as to require the coffer to be planked up. This space was left to permit the passage of rafts and logs until the water could be turned through the sluice way. The posts were then put in place, the planking put on the upper side, and the coffer was thus completed. This was done under difficulties consequent upon a heavy rise in the river, but was successfully accomplished. The space thus laid bare was built up with logs, care being taken to bond the whole well together, and the stone and planking was added. After the dam was completed, the coffer planks were removed and the posts sawed off. The abutments, of granite masonry, are 10 feet 6 inches above the crest of the dam, with provision, in case of an extraordinary rise in the river, for flashboards upon the abutments and wings of two or three feet more. The expense of the dam, abutments, and wing walls has been about $150,000, and it is considered one of the most substantial dams in the country.

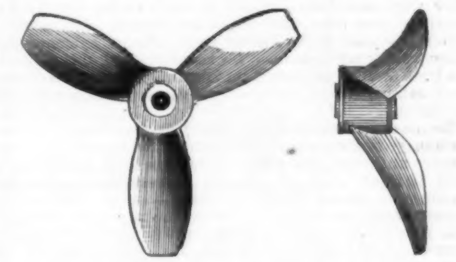
There is, at the lowest stage of the river, in the summer drought, a nominal horse power of 4,500 at mean high tide, and at low tide, of 8,700; this stage usually lasts about six weeks in the summer, and occurs in the winter for a shorter period, ordinarily about four weeks. This would give at the respective stages of the tide an effective horse power of about 3,600 and 7,000. The larger head has a duration of from one-third ebb to two-thirds flood, or for a space of about 8 hours out of the 12. Only about 45 horse power is used in driving the pumps for ordinary domestic service. The dam is so built that it can be readily increased in height when greater power is needed to supply factories and mills.

The line of the E. & N. A. Railway passes in the immediate vicinity of the dam, and will afford facilities for transportation of freight, without damage. Boats and sailing vessels of eight or ten feet draft can also come to the works to discharge and receive freight, while 20 or more feet of water is found at the railway wharves two miles below.

A fishway is being constructed upon the easterly end of the dam adjoining the abutment after plans furnished by C. G. Atkins, Esq., engineer of the U. S. Fishing Commission, at an expense of about $6,000. It has the general form of a spiral staircase, and will be ready for service in season for the spring run of fish.—*Engineering News.*

THORNYCROFT'S SCREW PROPELLER.

The propeller designed and patented by Mr. J. I. Thornycroft is shown by the subjoined engravings, from which it will be seen that the blades extend backward, at the same time curving outwards, the object being to prevent the dispersion of the water, and cause it to be thrown aft in a solid column. The screw has been applied with great success to the high-speed steam launches of which Messrs. John I. Thornycroft & Co. are well-known makers, and its application to a larger vessel is therefore a matter of some interest.



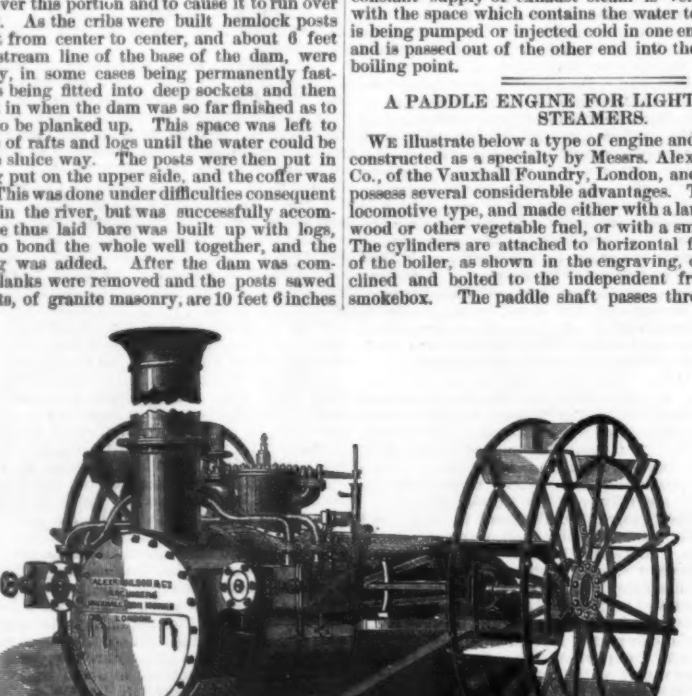
In the case of a torpedo boat, 58 ft. long, the substitution of one of Mr. Thornycroft's screws for an Admiralty screw with the corners cut off was found to increase the speed from 16¼ to 17½ miles per hour, while in Mr. Perkins' small steam yacht, the Emily, the application of one of these screws in place of Griffith's, raised the speed about one knot in seven. Similar results have also been obtained in other instances, the speed being increased and the vibration greatly reduced. —*Engineering.*

Heating Water for Steam-Engines.—The construction of the apparatus of Mr. John Coles, of London, consists of three cylinders of unequal diameter, so as to be inserted in each other, and forming a space between each for the exhaust steam and water. The innermost or smaller cylinder is to receive a portion or the whole of the exhaust steam, and passing through the same into the outer or larger cylinder, and returning back over the central cylinder, and thereby enclosing with exhaust steam internally and externally the space caused both by the smaller and central cylinders which contains the water to be heated. The space in the small cylinder and of the large cylinder which contains a constant supply of exhaust steam is very large compared with the space which contains the water to be heated, which is being pumped or injected cold in one end of the cylinder, and is passed out of the other end into the steam-boiler at a boiling point.

A PADDLE ENGINE FOR LIGHT DRAUGHT STEAMERS.

We illustrate below a type of engine and boiler now being constructed as a specialty by Messrs. Alexander Wilson and Co., of the Vauxhall Foundry, London, and which appears to possess several considerable advantages. The boiler is of the locomotive type, and made either with a large firebox to burn wood or other vegetable fuel, or with a smaller one for coal. The cylinders are attached to horizontal frames on the side of the boiler, as shown in the engraving, or they may be inclined and bolted to the independent frame carrying the smokebox. The paddle shaft passes through a tube in the barrel of the boiler, and all the bearings are bolted to an angle-iron framing fastened to brackets riveted to the boiler and quite independent of the hull of the boat, to which they are slightly secured. The engines are fitted with the ordinary link motion reversing gear, and the boiler is provided with two auxiliary pumps. A clip pulley may be provided for hauling the boat over Rapids by means of a rope.

The sizes manufactured by Messrs. Wilson & Co. range from 25 to 100 horse power, the dimensions of cylinders from 6 in. in diameter by 15 in stroke to 12 in. in diameter by 30 in. stroke, and the diameter of paddle-wheels from 5 ft. 6 in. to 11 ft. They are adapted for boats varying from 7 ft. 6 in. beam and 50 ft. long, to 14 ft. beam and 100 ft. long. —*Engineering.*



LIGHT DRAUGHT STEAMBOAT ENGINES.

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

Article VIII.

ON THE CATHETOMETER AND ITS PRACTICAL APPLICATIONS.

THE name Cathetometer, from two Greek words, *kathetos*, vertical height, and *metron*, a measure, shows that this instrument is used to measure the vertical distance between two points, or, what is the same, the difference in the level of two points. The cathetometer is formed of a rigid vertical rod which rotates around its axis and carries a telescope provided with a spirit level. The telescope is attached to a vernier-plate which slides along the rod, which is divided into millimeters. The rod revolves on a vertical axis which stands in the center of a tripod. By the aid of the levelling screws of this tripod and the spirit-level attached to the telescope, we can bring the axis of the rod into a truly vertical position.

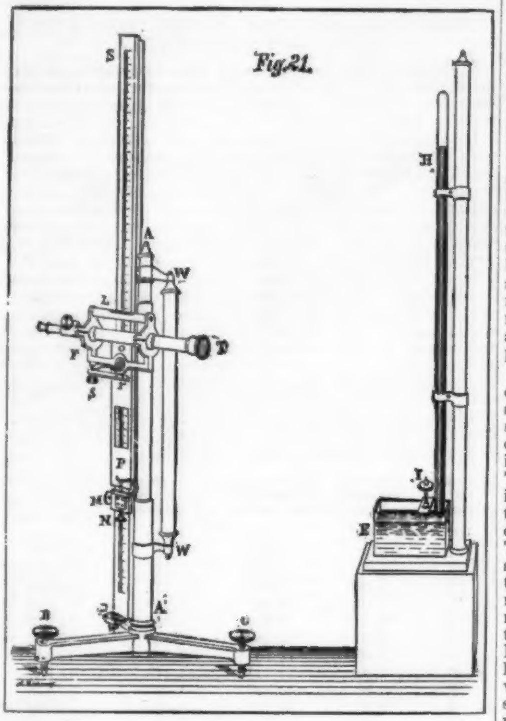


Figure 21 is a perspective drawing of a cathetometer. AA′ is a vertical brass rod which rotates on a central steel axis which is firmly attached to the center of the tripod B, C, D. S is a scale divided into millimeters. The long plate, on which this scale is engraved, is fastened to the rod AA′, and its weight, and that of the telescope which it carries, is counterpoised by the weight WW′ placed on the opposite side of the rod AA′. This counterpoise causes the weight of the rotating part of the apparatus to bear in the direction of the axis of the rod AA′, and thus insures its freedom from lateral pressure and deflection. The telescope T rests in Vs cut in the metal frame F. On top of the telescope tube rests the straddle-level L. The telescope and its level can be rotated around the pin *o* by means of the screw S which works in a rod *r* screwed to the vernier-plate P. This plate P, which carries the telescope and level, can be slid along the scale S by unbinding the screw M. The bottom of the vernier-plate P rests against the abutting screw N, which turns in a long nut attached to the plate which the screw M can bind to the scale rod S. From this construction it follows that if the screw M clamp this plate to the scale, then the vernier-plate P can be pushed up or lowered by turning the screw N. A spring keeps the vernier-plate always bearing on the end of the abutting screw.

If the axis of AA′ is vertical, and the line of sight of the telescope is at right angles to this axis, we can use this instrument to measure the vertical distance between two points, and it matters not whether these points are in the same vertical line or not. This measure is readily effected by placing two spider threads in the focus of the telescope; one of these threads is horizontal, the other vertical; or, if preferred, they may be inclined 45° to the horizon. The upper point, whose distance from a lower point we propose measuring, is bisected by the cross-threads, and the reading of the vernier is taken. The screw M is now loosened and the vernier-plate with its telescope is slid down the scale-rod S, till the lower point, to be bisected, just appears in the field of view of the telescope; then the screw M is turned to clamp the lower plate. With the screw N we now slowly let down the vernier-plate till the cross-threads in the telescope bisect the lower point. The scale is now read on the vernier, and the difference between this reading and the previous one gives us the vertical distance between two horizontal planes passing through the two points.

The above measure, as we have said, can only be made when the axis of rotation of the rod AA′ is vertical and the line of sight of the telescope is at right angles to this axis of rotation. Also the scale S must be an accurate one, and not out as much as the smallest reading on the vernier. We will now proceed to describe the method of putting this instrument in adjustment:

1. *To Bring the Axis of Rotation of the Cathetometer into a Vertical Line.*—Rotate the tube AA′ till the level is over or parallel to a line connecting the two screws B and C of the tripod. Then with one of these screws, say C, bring the bubble to the middle of the tube of the level. Now rotate the axis A A′, and thus revolve the level through half a circle, or 180°, and it will no doubt be found that the bubble is now no longer in the center of the level. Bring it to the center by moving it halfway there by turning the screw B, and then move it the other half or to the center, by turning a screw on the end of the level at L, not shown in the figure. This screw on the level raises or lowers the level with reference to the axis of the telescope L. When this adjustment has been repeatedly made, so that the bubble remains nearly stationary when the level is reversed as above on the line BC; then rotate the instrument till the level stands at right angles to the line BC, and when in this position, bring the bubble to the center of the level by turning the screw D. Then place the level parallel to the line BC and repeat the adjustment till the bubble remains perfectly stationary when reversed over the line BC, or when placed over the line drawn from D to the middle of the line BC. When this adjustment has been accomplished, the axis of rotation is vertical in two planes at right angles to each other, and therefore the axis is vertical when the telescope is placed in any direction around the axis, or, as the astronomers say, "when the telescope is placed in any azimuth."

We have now to bring the telescope T, to point at right angles to the vertical axis of rotation; but before we can do this, we have to correct the telescope of two errors which it no doubt possesses. These are the errors of *parallax* and of *collimation*.

2. *Correction of the Error of Parallax.*—The eye-piece of the telescope is moved either in or out till the cross-threads are distinctly visible; then the telescope is directed to a scale placed at the distance at which we wish to use the cathetometer. The cross-threads of the telescope are made to bisect a line on this scale, and then the head of the observer is moved up and down, or to the right and left. If during these motions of the head, the cross-threads remain stationary on the scale-line, then the plane of the image of the line in the telescope is exactly in the plane in which the cross-threads are stretched. If, however, the image should be in a plane beyond that of the cross-threads, then when the head is moved the cross-threads will appear to move in a direction which is opposite to that of the head; but if the image of the line is this side of the cross-threads, then a motion of the head gives a like apparent motion to the threads. This being understood, a little reflection on the reader's part will show him that the correction of the error of parallax is readily made by pushing in or pulling out the eye-piece and readjusting the focus of the telescope until the cross-threads appear perfectly stationary on moving the head past the eye-piece.

3. *Correction of the Error of Collimation.*—The error of collimation is the want of coincidence of the point of intersection of the cross-threads with the optical axis of the lens; so that when this error exists the point of intersection of the cross-threads appears to rotate around a fixed point (viewed in the telescope), when the telescope is revolved in its Vs. This error is corrected by means of four screws which work in the edges of a flat ring of metal in which are stretched the cross-threads. These screws are placed in the direction of the cross-threads, and are separated 90° from each other. To correct the error of collimation we first direct the telescope to a scale and make the telescope's horizontal thread to coincide with a line on the scale. Then the telescope is revolved in its Vs one-half of a revolution, and if after this rotation the line on the scale remains bisected, then we know that there is no error of collimation in the plane of this line. If, however, coincidence of this spider-line and the scale-line is not held after the rotation, we move the thread halfway over the distance which now separates it from the scale-line by turning the vertical screws which move the plate on which the threads are stretched. In doing this we should always loosen one screw before tightening the one opposite it. The telescope is now revolved in its Vs back to its first position, and the telescope is slid down or up the scale-rod till the cross-thread again coincides with the line. The telescope is again turned through 180° in its Vs, and if the spider-line now coincides with the scale-line the error of collimation has been corrected. If the coincidence does not take place, then we have to repeat the adjustment with the cross-thread screws till it is attained. The other cross-thread is now submitted to the same operation. When the adjustment of both threads is perfect, the point of intersection of these threads will remain stationary on a point of sight when the telescope is revolved in its Vs.

4. *To Place the Line of Collimation of the Telescope at Right Angles to the Axis of Rotation of the Cathetometer.*—With the cross-threads of the telescope we bisect a line on a fixed vertical scale. Then the cathetometer is turned through 180°, and the telescope is very carefully taken out of its Vs and then placed in them again in a reversed position, that is, the eye-piece end of the telescope is placed in the V where the object-glass previously was. Thus the instrument has been turned through half a circle and the telescope is again sighting on the line on the scale. If the intersection of the cross-threads now bisects the line, then the line of collimation of the telescope is at right angles to the axis of rotation; if, however, the bisection does not occur after the revolution of cathetometer and reversal of telescope, then the telescope is moved by its screw about the pin *o* as a center of motion, and by this motion the intersection of the cross-threads are moved just one-half way towards the line. This adjustment is repeated until the line on the scale remains bisected when viewed through the telescope in its direct and in its reversed position.

By the above-described adjustment, however, we have tilted the level which has not been touched since with it we placed the axis of rotation of the cathetometer in a vertical line. But this axis of rotation has remained vertical, although now the bubble of the level is not in its center; hence it merely remains to turn the screw on the level at L, and with this motion bring the bubble again to the center of the level. The instrument is now in complete adjustment and ready to use, provided the vertical scale on the cathetometer is correct.

5. *To Test the Accuracy of the Scale on the Cathetometer.*—An accurate scale, or one whose errors of graduation have been determined, is placed in a vertical plane. The telescope of the instrument is slid to the top of the scale rod S, and the telescope is made to bisect one of the lines on the scale. The vernier is then read and noted. The telescope is then unclamped and moved downwards till its threads bisect the next line on the scale, and the vernier is again read off. Thus all of the divisions on the scale are successively bisected, and their known distances apart are compared with the corresponding measures made with the cathetometer scale. The whole of the cathetometer scale is thus repeatedly compared with the standard scale, and the errors of the graduations of the instrument are put into a tabular form for correcting our measures made with the cathetomer.

Practical Applications of the Cathetometer.—The cathetometer is very extensively used in the laboratories of the physicist and the engineer. Whenever we wish to know with accuracy a vertical length, this is the instrument which is used to give us the information; hence it is employed to measure the heights of columns of mercury in barometers and manometers, to determine the distance between the points on a rod subjected to tractile strain, and to measure the amount of deflection which beams experience when they are variously loaded with weights.

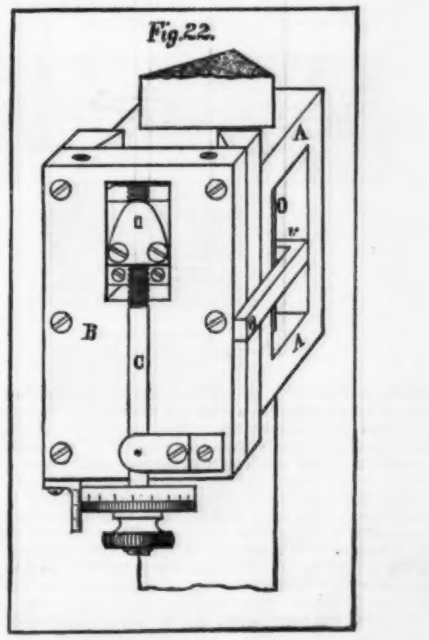
As an illustration of the manner of using the cathetometer, we will describe how one measures with it the height of the column of mercury in a barometer:

H represents a barometer supported in a stand. E is a cistern of mercury, into which penetrates the open end of the barometer tube. The problem before us is to measure with the cathetometer the distance from H, the surface of the mercury in the tube, to the surface of the mercury in the cistern E. I represents an index, formed of a screw, pointed at both ends. This screw is turned up or down in a plate which is shown as resting on the top of the sides of the cistern. The length of this index from one terminal point to the other is very accurately determined by placing it in a vertical position, and then measuring it repeatedly with the cathetometer. To measure the height of the mercury column, we first slowly screw down the index I, until its lower point just touches the surface of the mercury in the cistern. This is known by observing when the point of the index and its reflection in the mercury appear to touch each other; or, in case the surface of the mercury is tarnished, we screw down the index till its point makes a depression or dimple in the mercury, and then slowly screw the point up wards till this dimple just disappears. This condition can be very accurately determined by viewing the surface of the mercury obliquely, when the slightest dimple will be very plainly seen. The lower point of the index I, having thus been adjusted to touch the surface of the mercury, the horizontal thread in the telescope is brought to be tangent to the top of the curved surface of the mercury in the tube at H, and the vernier on the cathetometer scale is read. Then the telescope is slid down its scale till its horizontal thread just touches the top point of the index I, and the cathetometer scale is again read off. This reading, subtracted from the previous one, gives the distance from the top of the column of mercury to the point of the index, and this measure, added to the length of the index I, gives the height of the mercury in the barometer.

The cathetometer, which we have already described, is one of the forms usually given to this instrument in European shops, but the instrument as thus constructed has inherent defects which unavoidably introduce errors into our measures, no matter how careful our manipulations of the instrument may be. One of the main causes of these errors of measurement resides in the method employed to clamp the vernier plate which carries the telescope, and to give to this plate the fine motion required to make neat bisections.

A better plan of moving the vernier and telescope along the graduated rod is that contrived and repeatedly constructed by Mr. William Grünow, Instrument Maker at Columbia College, New York city. We cannot do better than here quote from his description of his improved cathetometer, as published in the *American Journal of Science* for January, 1874: "I have recently constructed for the Physical Cabinet of Columbia College, a cathetometer, in which, by the use of another arrangement, great steadiness and accuracy of movement are attained, in combination with simplicity.

"Upon a graduated, vertical, triangular brass bar, slides a *single* block which carries the telescope and the micrometric arrangement for the fine adjustment. On one of the sides of this block, which is fastened in position by a thumb-screw, is dovetailed the slide B (Fig. 22), which, being provided



with adjusting screws, can be made to move steadily and accurately. The slide B is moved up and down the block A, by the micrometer screw C, which is mounted in such a way that its motion cannot interfere with the steadiness of the movement of the slide B; it can also be adjusted so that it works without dead motion.

"Each turn of the screw corresponds with one division of the graduated bar on which the block A slides. The slide B carries an arm with an index V, which moves in an opening O, cut out in the side of the block A, corresponding to the graduation on the bar. The screw carries a movable head, divided into one hundred parts, and by means of its index, fractions of a turn of the screw, or rather fractions of one division on the bar, can be read off easily and accurately. The levelling telescope is screwed on the top of the slide B.

"The screw which I used for this instrument had a millimeter thread, and its head being divided into a hundred parts gave hundredths of a millimeter.

"In testing the instrument with the higher power, I felt gratified that measurements could actually be made to the hundredth part of a millimeter, and confirmed by repetition.

"To make the instrument more generally useful, the objective of the telescope is provided with a draw-tube which

adds four inches to its length, and permits observations to be taken at as short a distance as three or four feet. In addition, it is provided with a brass cap, which can be slipped over the mounting of the objective, and which carries a supplementary centered achromatic lens, which permits the instrument to be approached to within a distance of six inches from the object. When thus arranged, it enlarges the actual dimensions of objects about forty diameters, but even with this rather high power, the smoothness and steadiness of the micrometric movement seems in no degree impaired. —Columbia College, Nov. 4, 1873."

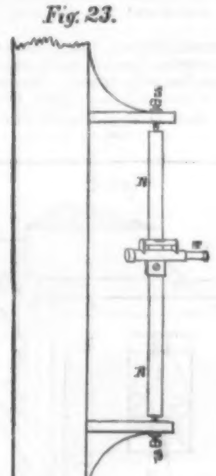
The following series of measurements made with Grünow's cathetometer at my request, by Professor Rood, of Columbia College, seems to show the degree of precision attained with this improved instrument:

	MEASURES. Millimeters.	DIFFERENCES. Millimeters.
1	762·688	+ 0·0005
2	·687	— 0·0005
3	·688	+ 0·0005
4	·685	— 0·0025
5	·689	+ 0·0015
6	·687	— 0·0005
7	·689	+ 0·0015
8	·684	— 0·0035
9	·689	+ 0·0015
10	·689	+ 0.0015
	762·6875 = Mean.	

The first column above gives the successive ten measures. The mean of these measures is 762·6875. The difference between this number and the successive separate measures is given in the column headed Differences. We here see that the greatest departure of any separate measure from the mean amounts to only $\frac{35}{10000}$ths of a millimeter, or $\frac{1}{7143}$ of an inch. The reader will also observe that all of the measures in the first column agree to the $\frac{1}{100}$th of a millimeter or $\frac{1}{2500}$th of an inch. Thus we see that an examination of these measures fully sustains Mr. Grünow in his statement that "he felt gratified that measurements could be actually made to the hundredth part of a millimeter, and confirmed by repetition."

The cathetometer is a measuring instrument of such general utility in both scientific and practical work that I have endeavored to render it so simple in construction that almost any one who has many measures to make may have one of these instruments at a small expense. The cathetometer, even when provided with Grünow's improvement, requires great delicacy of handling from the manner in which the vertical rod is supported. This rod is liable to flexure and vibration from the heavy sliding weight of the clamp and telescope; also the adjustment of this rod in the vertical is liable to be destroyed by the strain put on it when the telescope is moved up the rod. These objectionable features in the cathetometer are overcome and the instrument much simplified by adopting the construction of which we give a

Fig. 23.



sketch in Fig. 23. A vertical rod R, divided into millimeters, is supported in a vertical position on the points of two hard steel screws, SS. These screws go through two heavy brackets, firmly fixed to a column of the building or embedded in the walls of the house. The lower of these screws goes through a plate of metal which is held in place by four opposing screws. By means of the latter the plate can be moved laterally, and by these lateral motions the rod is adjusted to a vertical position. The telescope and level are shown at T. This form of cathetometer remains in one position, and the apparatus on which the measures are to be made has to be brought to the cathetometer; but this disadvantage is more than counterbalanced by the greater stability of the instrument, and by the *permanence* of its adjustments.

TONOMETRY.

MUSICAL tones and other sounds are produced by vibrations of the particles of the atmosphere, and the rate of vibration producing a tone of a given pitch has hitherto been most accurately determined by means of the siren or the monochord; but, according to Mr. A. J. Ellis, the methods employed with those apparatus are liable to result in the introduction of numerous errors. The problem of tonometry is to determine with absolute accuracy the number of vibrations made in a given time by each particle of air conveying the undulations which produce in human ears the sensation of a musical tone; or, in other words, if we take a string or a reed yielding the note known as mid. C, to determine the number of vibrations made by the string or the reed in one second of time. The old attempts at tonometry, says Mr. Ellis, in a paper contributed a few months ago to the *Athenæum*, were made by a monochord, which was horizontal, or, much better, vertical, stretched by a weight mathematically determined by the transverse section and specific gravity of the string, and limited by a fixed bridge at one end, and a movable bridge at the other. The pitch could then be calculated from the measured length of the string. More recently the siren, in which a perforated plate was driven by a stream of air with increasing but constantly measured velocity, producing a constantly higher note, has been extensively used. The pitch of the given note had to be determined by the estimation of the ear as to when the monochord or siren gave a note identical with that under examination. All these methods are liable to numerous errors, and practically their results cannot be depended on to ten vibrations in one second. Other methods were still worse.

Tonometry was first placed on a scientific basis in a badly written but extremely valuable little pamphlet, published at Essen, in 1834, by Heinrich Scheibler, silkware manufacturer in Crefeld. The principle upon which Scheibler proceeded was this:—Tones which differ by a small amount "beat" together—a very familiar phenomenon—varying from a slow wave to a rapid rattle; and the number of beats in a second is precisely the same as the difference in the numbers of vibrations which the two tones make in a second. A tuning-fork will also beat with an imperfect octave above it, and then the number of beats is the difference between the number of vibrations of the upper tone, and double the number of vibrations of the lower tone. Thus 256 and 259, or 256 and 253, beat three times in a second; and 256 and 515, or 256 and 509, also beat three; that is, the beats do not show whether the upper note is too sharp or too flat. This has to be ascertained by flattening the upper tone (warming the upper tuning-fork under one's arm for a minute or two is sufficient); if, then, the beats diminish in number, the upper note is brought more in tune, and was too sharp; if the beats increase in number, the upper note is brought more out of tune, and was too flat. Then two forks being tuned roughly to, say, A on the first line on the bass staff, and the A above it, the upper A is flattened till it beats exactly 4 times in a second with the lower. A third fork is now tuned 4 beats (in a second, as must be always understood) sharper, and will give the exact octave of the lowest fork, without any wave or error. Then proceeding downwards by 4 beats at a time we reach a fork which beats sharp 4, or less than four, times with the original fork, and these beats are accurately counted. The sum of all the beats of all the forks, two and two, from the lowest to the highest, is necessarily the exact number of vibrations of the lowest, because these beats represent the number of vibrations to be added to the lowest in order to produce its octave, the highest, which has twice as many vibrations. Thus, the absolute pitch is known of all the forks used, and forks can be tuned to any intermediate pitch by less than 4 beats in a second. The construction of such tonometers of forks, large in size, never touched by the hand, kept at a constant temperature, and anxiously observed and re-observed, is a matter of great difficulty. Scheibler's original tonometer had 52 forks extending from A 219⅔ (that is the note called A, and making 219⅔ vibrations in a second) to A 439⅓, but proceeding by unequal numbers of beats. Koenig, of Paris, subsequently improved on this by making one of 65 forks from C 256, to C 512, proceeding by 4 beats, and added two other forks, F 341⅓, and A 426⅔.

These instruments, with proper precautions, says Mr. Ellis, do excellent work. But they are cumbrous, costly, excessively variable with temperature, extremely mild in quality of tone, which prevents verification by any interval but the octave; with notes difficult to sound more than two at a time, and difficult to flatten and restore to pitch rapidly. These inconveniences are practically overcome by the tonometer made by Appunn, and exhibited in the Loan Collection of Scientific Apparatus at South Kensington, London. It is of small and comparatively convenient size, and its tones are not nearly so much affected by change of temperature as those proceeding from tuning-forks. The notes are extremely reedy in quality of tone, so that the 16th partial can be made effective, and hence all intervals used as verifications. The notes are also easy to sound and to damp in any number at a time; and to flatten any one separately and instantly or gradually, by 1, 2, or even 3 vibrations, and to restore immediately to the former pitch. This last is one of the most important properties of the instrument. It consists of 65 harmonium reeds, actuated by pulls numbered 0 and 1 to 64, which, when pulled out completely, give the true tone, and when gradually pushed in flatten the tone. The pitch is from C 256 to C 512, increasing regularly by 4 vibrations.

Using this instrument to measure forks, I found, says Mr. Ellis, great discrepancies between the numbers shown and the numbers stamped on the forks. For my own satisfaction, therefore, I verified the instrument as follows: First, I counted the beats with a pocket chronometer between pulls 0 and 1 for 15 seconds, and I found them 60, or 4 in a second. Next I counted the beats between each pair of the other adjacent pulls for 20 seconds, and found them always 80, or 4 in a second. Hence the whole increase was 4 times 64, or 256 vibrations. I then examined, first, the usual consonances on the instrument, consisting of 1 octave 1:2, 11 fifths 2:3, 11 fourths 3:4, 10 major thirds 4:5, 9 minor thirds 5:6, 4 major sixths 3:5, 4 minor sixths 5:8; secondly, the septimal consonances, 6 sub-fifths 5:7, 4 super-major thirds 7:9, 8 sub-minor thirds 6:7, 3 sub-minor sevenths 4:7; and thirdly, the usual dissonances, having audible identical partials, 7 major tones 8:9, 5 minor tones 9:10, 4 diatonic semitones 15:16; or 87 just intervals on the whole. For every one there was the proper rapid rattle of beating partials, but not the slightest wave of error in the identical partials. This wave was, however, instantly produced by flattening the upper reed, and made to disappear by flattening the lower reed at the same time to the proper extent, and to reappear by flattening the same more. I have, therefore, a mechanical guarantee that every one of these intervals was correctly represented on the instrument. But every one of them separately proved, after counting the beats, that the lowest tone made 256 vibrations in a second, and the whole set by their perfect agreement proved that the beats had been correctly counted. The introduction and extinction of the beats of error were often very remarkable. By conscientiously trying every one of 87 cases, I have convinced myself, says Mr. Ellis, of the perfect trustworthiness of the instrument, and those to whom I have shown some of them, have been equally convinced, among whom I need only mention as most competent to decide, Mr. A. J. Hipkins, of Messrs. Broadwoods, and Mr. E. Greaves, of Sheffield, a large maker of tuning-forks for Messrs. Broadwoods, and the whole music trade, who has now accepted the 256, 384, and 512 of Appunn's instrument as absolutely correct, and copied them on forks.

An examination, by means of this tonometer, of a number of standard forks, developed some remarkable results. Handel's fork, 1751, gave A 426·4, C 507·14—this fork was used at the Foundling Hospital, when the "Messiah" was performed, and a contemporaneous note stated, "Antient concert, whole note higher; Abbey, half tone higher; Temple and St. Paul's organs exactly with this pitch." A series of other forks from the best authorities proved to vary in small amounts from their supposed values, and compared when reduced to C's 510·1, 512, 515·82, 517, 517·25, 518·52, etc.; while a French normal, which should have been A 435, proved A 439, C 522·06. Close to this figure comes the fork of Sir George Smart, C 521, Messrs. Broadwoods' "low pitch" C 523. The "Stuttgart pitch," C 523·25, the Vienna orchestra, 1834, C 524·29. And finally, there was tested a series of higher forks, Broadwoods' medium C 535, and others, of which Sir M. Costa's Philharmonic Wind Band Concerts of C 542·5, and Broadwoods' high-pitch C 545·2 are examples.

Mr. Ellis expressed the hope that the introduction of Appunn's tonometer would bring about uniformity of pitch, and at least settle the standard pitch for England. Within certain limits it is immaterial what number of vibrations is accepted as a standard pitch; the simplest would appear to be to make C 512, when, with a ready means of testing their forks, musicians, and especially musical instrument makers, would have reason to thank Herr Appunn.—*English Mechanic.*

NEW INVESTIGATIONS ON THE COMPOUND ELECTROPLATING BATH.

M. THENARD has recently made some investigations into the advantages of the compound bath in electroplating, the source of the current being a Gramme magneto-electric machine having a permanent Jamin magnet, and driven by a Lenoir engine. The liquid used was composed of 125 parts of sulphate of copper, the same amount of concentrated sulphuric acid, and 1,000 parts of water. Number of revolutions from 1,200 to 1,300 per minute. The anodes immersed in each bath were three plates of 64·7 inches area, each placed parallel and facing each other. The outer plates of each group, distant from the middle one 0·78 inch, worked positively, the inner plate negatively, so that the latter on its two faces became charged with the copper from its neighbors. Sixteen baths were arranged and the current established. At the end of one hour the exact weight of the middle anodes were determined, there being upon each a regular and strongly adherent deposit. Then at intervals of twenty minutes thereafter one bath was removed, so that the current might first pass through sixteen, then fifteen, and so on, until all the baths had been taken out of action. The middle anode of each bath in turn or stoppage was removed, washed, dried, and accurately weighed. The following table exhibits the results of the investigation:

Number of baths.	Period of immersion h. m.	Augmentation of weight of each anode.	Gain per anode and per 20 minutes.	Total weight of copper deposited in 20 minutes.
16	0.20	1,210	1,210	19,360
15	0.40	2,445	1,222	18,330
14	1.00	3,725	1,241	17,374
13	1.20	5,085	1,271	16,523
12	1.40	6,495	1,299	15,588
11	2.00	7,995	1,332	14,652
10	2.20	9,535	1,362	13,620
9	2.40	11,155	1,394	12,546
8	3.00	12,775	1,419	11,352
7	3.20	14,535	1,453	10,171
6	3.40	16,270	1,480	8,880
5	4.00	18,040	1,500	7,500
4	4.20	19,990	1,540	6,160
3	4.40	22,000	1,570	4,710
2	5.00	24,140	1,610	3,280
1	5.20	56,290	1,640	1,640

It will be seen from this that the quantity of copper deposited in a given time augments with the number of baths, although the anodes of each one of the latter is charged with a less amount of metal. The mechanical effort on the other hand was found to increase very sensibly with the diminution in number of baths. These experiments were many times repeated with uniform results. The anodes were then connected for quantity instead of for tension, and it was found that the sum of all the deposits was constant regardless of the number of anodes. The quality of the deposit was moreover improved in proportion to the augmentation of the latter. M. Thenard is endeavoring to determine the general laws governing these results.

UNDERGROUND TELEGRAPH LINES IN PARIS.—Paris, as is generally known, possesses a very complete system of sewers. They are not what may be regarded as merely large drains, but are veritable subways, in any of which a man may freely move about. The main sewers are broad and lofty tunnels with footways on either sides—the sewage flowing at low level in the centre. They are kept scrupulously clean, and frequent manholes opening into the foot pavement above give means of access, light, and ventilation. As may be imagined, Parisian engineers have not been slow to recognize the advantages which such a system of subways present for laying telegraph wires, pneumatic tubes, water and gas mains. Within the city of Paris there are 119 miles of underground line, of which 39 miles are laid in buried iron pipes, and 80 miles are in lead tubing laid in the sewers. The total length of wire is 2,561 miles. In the chief provincial towns in France there is about 100 miles of similar lines at work.

BALL LIGHTNING.

A VERY fine display of this interesting meteor was witnessed at Vence, in the south-east of France, on the night of March 21-22, by M. Ed. Blanc, of which an interesting detailed account has just appeared in the *Comptes Rendus* of the French Academy. Toward midnight there was observed, about eleven miles north-east of Vence, a large black thundery cloud, in a state of extreme agitation, and continually raising and lowering its position. At the upper part of this cloud three or four balls of fire issued every two minutes, as if from the invisible centre of the cloud, diverging in all directions, and after running a course of from six to eight degrees, broke silently with effulgent brightness. Their apparent diameter, as seen at a distance of eleven miles, was about a degree. They were mostly of a reddish color, a few, however, being of a yellowish tinge, but all of them assumed a white color in the act of bursting. Their course, which was horizontal and parallel to the plane of the cloud, was relatively slow, not exceeding two degrees per second, and they bore a strong resemblance to immense soap-bubbles, both as regards apparent lightness and general appearance. From time to time a discharge of lightning passed through the cloud from above downwards, followed some seconds after by a dull rumbling sound. The cloud, with its fine display of fire-balls, took a course from east to west, passing about a league to the north of Vence. The glimmering of

the lightning with its low dull thunderous sound continued for more than an hour, after which the sky became darker and darker; rain mixed with hailstones fell, and lightning accompanied with thunder, furrowed the sky in all directions.—*Nature.*

IMPROVEMENT IN DYNAMO-ELECTRIC MACHINES.

By DIEUDONNÉ F. J. LONTIN, Paris, France.

THIS invention relates to certain improvements in dynamo-electric machines, designed to produce alternate currents in opposite directions, for the production of electric lights or other purposes, as well as currents invariable in direction.

Fig. 1, A, represents a series of inducing-magnets, arranged radially about an axis, so as to revolve therewith, while B represents a series of induced magnets, which are made stationary, and project inwardly toward the inducing-magnets. These induced magnets B serve each as so many independent sources of electricity of alternately reversed currents, and may be utilized for producing any number of electric lights, or for other purposes. To excite them, however, it is necessary that the inducing-magnets A be rotated and charged by an electric current invariable in direction. For thus charging the inducing-magnets A, I employ the device for producing said invariable currents, which is illustrated in Fig. 2.

In this case the relation of the induced to the inducing magnets is the reverse of that shown in Fig. 1, in that the inducing-magnets A^1 A^2 are here stationary, while the induced magnets of the wheel are movable.

This induction-wheel P consists of a metallic shaft, upon which are arranged radial arms at right angles to the axis, which arms form cores of the magnets D'. Each of said cores is provided with a coil of covered copper wire of which the ingress end E of one coil is connected with the egress end S of the next coil, so as to form a series of induction-coils, connected together in such a way as to produce a circuit completely closed upon itself. The extremities of each of these coils is electrically connected at C^1 with insulated contacts C upon the boss of the wheel, and upon which contacts the rubbers or springs *a a'* bear in the line X X, to take off the currents which are invariable in direction.

To understand the effect produced by imparting rotary motion to the induction-wheel in front of the poles of a magnet or electric magnet, it is necessary to refer to the action of magnetism upon coils having iron cores.

In an induction-coil consisting of an iron core with a certain length of copper wire wound around it, the two extremities of the wire constitute the two poles of an instantaneous battery, if the central iron core is submitted momentarily to the influence of a magnet. The current produced is different according as the coil is presented to the north or south pole of the magnet, and according to whether the pole is approaching or receding, which effects may be thus enunciated:

First, when an induction coil is made to approach a negative pole, there is produced in the wire of the coil an induced electric current in the inverse direction to that of the inductor (a magnet being considered as a solenoid, according to the theory of Ampère).

Second, if the same coil is made to recede from the same pole, the direction of the current is reversed. It is then direct—that is to say, in the same direction as that of the inducer.

Third, when an induction-coil approaches the south pole of the magnet, the electric current produced is in the same direction as that which would be produced if it were made to recede from the north pole.

Fourth, when approaching the north pole and receding from the south pole, the effect produced is the same, but inverse as regards general direction to that indicated in clause third.

These four laws being premised, suppose an induction wheel, P, to be rotated, as before stated. If the axis of this wheel be in the polar line X X of a magnet or electro-magnet, the effect in accordance with the third law will be that all the coils above the polar line produce a current in one direction, as indicated by the small arrows, since they are all approaching the south pole and receding from the north pole. The coils below the polar line, approaching the north pole and receding from the south pole, also produce a current in one direction, but inverse to that of the coils above the line.

The magnetic polar line X X thus really divides the coils of the induction wheel into two equal series—those above the magnetic polar line and those below the same—while the enveloping wires of the coil are still connected together, so as to form a completely closed circuit.

If the electricity generated in the upper series of coils is generated in the opposite direction in the lower series, there will be in the magnetic polar line on the one side a double positive pole, *p p*, and on the other a double negative one, *n n*, so that if by two conducting rubbers or blades, *a a'*, contact with the insulated plates of the coils is established on the line of the double positive pole *p p* and the double negative pole *n n*, we have the two poles of a powerful source of electricity, yielding a current invariable in direction; and if I employ a part of the electricity produced to excite the electro-magnets A^1 A^2, as indicated in dotted lines, I secure a constant and automatic supply of electricity of invariable current. The primary source of the current is supplied by the feeble residual magnetism of the electro-magnets A^1 A^2, or by charging them once for all.

The invariable induction currents, which are at first very weak, are collected by the two rubbers, as they are produced and returned into the electro-magnets A^1 A^2, which thus become gradually stronger, and consequently produce in the coil induction currents of increasing intensity as the rotation is accelerated. These currents are continuous, and become constant as soon as the speed of rotation is maintained constant.

In constructing the inducing electro-magnets A^1 A^2, I prolong the cores of the same, and locate upon said prolongation separate coils C^2 C^2, in which coils induced alternate currents of opposite direction are produced, so that by the single device illustrated in Fig. 2 both currents invariable in direction are produced (taken from rubbers *a a'*), and alternate currents in opposite direction (taken from coils C^2 C^2), and this, too, without the use of additional rubbers and a commutator for the said alternately reversed currents.

Now, if a number of separate sources of electricity of alternately reversed currents is desired for producing any number of electric lights, or for other purposes, the device illustrated in Fig. 1 is combined with that illustrated in Fig. 2, after the manner shown in Fig. 3, and the invariable current which is taken from the rollers *a a'* through the coils A^1 A^2 is passed through the revolving inducing magnets A by means of additional rubbers G G', and the magnets A, being excited thereby, produce, in working alternate currents in opposite direction in the stationary magnet B, each of which constitutes then an independent source of electricity for the production of a number of electric lights, or for similar purpose.

THE ASTEROIDS.

By PROFESSOR C. A. YOUNG.

EVERY now and then the papers announce the discovery of a new planet. The occurrence, indeed, has become so frequent of late as to attract very little notice except from professed astronomers, and they, to speak the truth, are none too cordial in the welcome of the little strangers thus added from time to time to the already embarrassingly large family under their charge. For while these new planets are quite as troublesome to provide with ephemerides and orbits as their larger sisters, they are extremely insignificant as regards their importance in the economy of the solar system, being seldom more than forty or fifty miles in diameter, and, as individuals, entirely without sensible influence upon the motions of other heavenly bodies. We say as individuals, because they belong to a numerous group known as the Asteroids (so called because they look like little stars), and the united attraction of the whole family does produce upon the orbit of Mars a perfectly sensible, though very minute, effect, from which Leverrier has computed that the combined mass of the whole flock would suffice to make up a globe not exceeding one-third the size of the earth, and probably a good deal smaller.

At present the number of these bodies known is 172: the whole number is probably to be reckoned by thousands, since it would take more than five hundred of the largest of them to make up the mass named.

Ceres, the first of them, was discovered on the first day of the nineteenth century, that is, January 1, 1801.

It had been noticed nearly two hundred years before, by Kepler, that the progression in the numbers representing the distances of the planets from the sun is such as to suggest the existence of an invisible body in the space between Mars and Jupiter, and he at one time went so far as to predict its discovery. He abandoned the idea, however, supposing that in his celebrated, but fantastic, theory of the polyhedrons he had found the key to the mysteries of the planetary system. Titius, in 1772, revived the original suggestion, and gave to the law of distances nearly the same form as that in which it was stated a few years later by Bode.*

In 1781, Uranus was discovered at a distance from the sun so closely corresponding with the law as to satisfy astronomers that it could be no mere accidental coincidence; and to confirm them in the belief that there must be a missing planet outside of Mars. The impression was so strong that an organization of twenty-four astronomers was formed by the exertions of Baron Zach, to search for it. Curiously enough, however, the good fortune of discovery did not fall to any one of their number, but to Piazzi, the Sicilian astronomer, who, on the opening night of the century, in the course of observations for his famous star-catalogue, came upon a star of the seventh magnitude, in a place where a short time before he was sure no such object existed. In a single day its motion was sufficient to prove its planetary character, and he continued to observe it, though much hindered by ill health and unfavorable weather, until it was lost in the rays of the sun. He was the only observer, however, for in those days communication was so slow that the planet had disappeared before the Continental astronomers could be notified of the discovery; and to find it again was hardly less difficult than at first. Gauss, then just beginning his career, came to the rescue with a new and entirely original method, by which

* The law is generally, but unjustly, known as Bode's, and may be stated thus: set down a row of 4's, as many as there are planets. To the second 4 add 3; to the third 4, twice 3; to the fourth, four times 3; and so on, each time doubling the number added. The result is as follows:

	☿	♀	⊕	♂	Asteroids.	♃	♄	♅	♆
	4	4	4	4	(4)	4	4	4	4
		3	6	12	(24)	48	96	192	384
A	4	7	10	16	(28)	52	100	196	387
B	4	7	10	15	28	52	95	192	300

The line A gives the numbers derived from the rule, and the line B the actual distances, correct to the nearest unit. While the agreement is generally close, it will be seen that in the case of Neptune the law breaks down completely; but Neptune was not discovered until 1846.

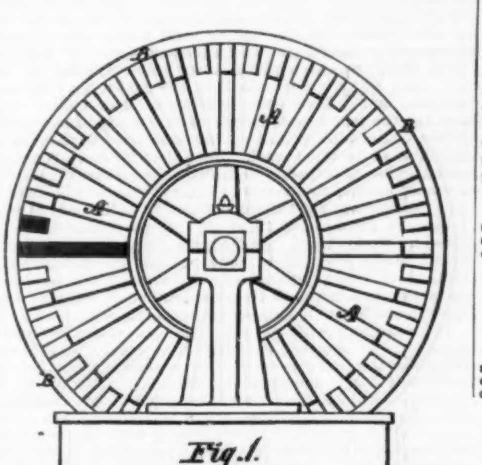


Fig. 1.

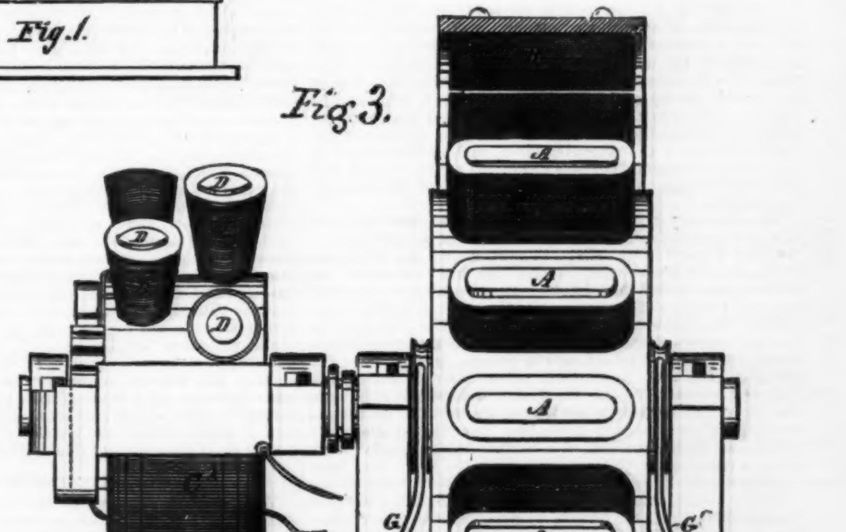


Fig. 3.

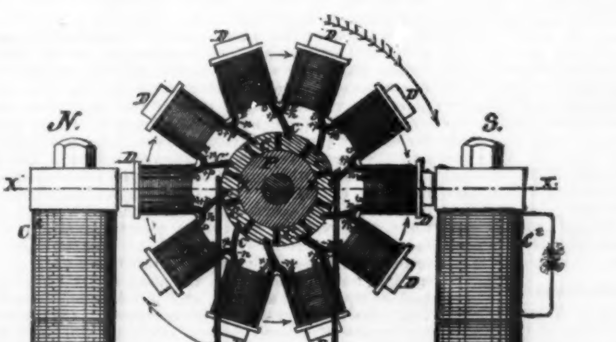


Fig. 2.

LONTIN'S IMPROVEMENTS IN DYNAMO-ELECTRIC ENGINES.

from Piazzi's six weeks of observation he deduced the planet's orbit and computed an ephemeris by means of which Zach rediscovered it on December 31st, and Olbers, independently, on January 1st.

In searching for Ceres, Olbers had noted carefully the configuration of telescopic stars in that part of the sky where he expected to find her, and on re-examining the region a few weeks later he was so fortunate on March 28, 1802, as to discover another planet, Pallas. The existence of two of these little bodies suggested the hypothesis that they originated in the breaking up of a much larger body, of which, probably, numerous fragments must exist which might be found by careful search near the points where the orbits of Ceres and Pallas intersect. A search was instituted, and in 1804 Juno was discovered by Harding, and in 1807, Vesta, the only one ever visible with the naked eye, by Olbers. The hunt was kept up until 1816, but without result, as the observations did not include stars sufficiently faint.

About 1830, Hencke, postmaster of the little village of Driessen, took up the subject, and after fifteen years of patient searching was rewarded by the discovery of Astræa in December, 1845. The year 1846 was sufficiently signalized by the discovery of Neptune; but since then not a year has passed without adding to the roll of the Asteroids. In 1861 and 1876 each, 10 were discovered; in 1872, 11; in 1868, 12; and in 1875, 17.

The list of discoverers includes 31 different names: 14 of them stand credited with a single planet each, and 10 with 5 or more apiece. Dr. Peters, of Clinton, New York, heads the list with 26; Luther, of Düsseldorf, comes next with 20; then follows Watson, of Ann Arbor, with 19, and Goldschmidt, of Paris, with 14. Fifty-two of these planets were discovered in France, 51 by American observers, 39 by Germans, 19 in England and its dependencies, and 11 in Italy and Sicily.

The orbits of these bodies have an average radius of not far from 250 millions of miles, with a corresponding period of a little less than five years. But individual orbits differ widely from these figures. Thus Flora, the nearest to the sun, has a period of only 1,193 days—a trifle over three years and a quarter—and a mean distance of only 202 millions of miles; on the other hand Hilda, the most remote, has a period of 2,868 days, or very nearly 8 years, and the radius of her orbit is more than 360 millions of miles. The orbits of the large planets are all nearly circular; many of the asteroid orbits, on the contrary, are very eccentric, resembling those of comets. Thus Æthra has an eccentricity of 0·38, which amounts to saying that her least distance from the sun is considerably less than half her greatest. The inclinations of some of their orbits are no less remarkable, that of Pallas being more than 34°, while that of Mercury is only 7°, and even that is altogether exceptional among the older planets.

As has been said before, the asteroids are very minute, too small, indeed, to have their diameters determined with any certainty by direct measurement; we are limited to approximate results obtained by comparing their apparent brightness with that of planets whose size and distance from the sun are known. If we knew the reflecting power of their surface—their *albedo* as it is called—we could thus arrive at reliable conclusions; but wanting this element and being obliged to content ourselves with the mere assumption that this *albedo* does not differ much from that of the planet Mars, values inferred in this way must be accepted with a good deal of reserve. Littrow, Lespiault, and others have investigated the matter, and find that the diameters of the larger ones range from 300 to 150 miles, while the smaller ones lie between 15 and 30. They are so small that a good walker could easily make the circuit of one of these microscopic globes in a single day, and unless their density is much greater than that of any of the other planets, the force of gravity must be several hundred times less than that on the earth's surface. A stone thrown from a boy's sling would fly off into space, never to return. We have spoken of them as globes, but certain otherwise unexplained variations in the brightness of some of them, especially Pallas, have suggested the idea that they may be irregular pieces of rock rather than spheres.

As to their origin two theories are held: one, that they are the fragments of an exploded planet, the other, that the ring of nebulous matter, which in different circumstances would, according to the nebular hypothesis, have formed a single planet like the others in the system, was in this case broken up, mainly by the action of the great planet, Jupiter, just outside. If the first hypothesis be so modified from that proposed by Olbers as to introduce the idea of a number of disruptions, first of the original planet, and afterwards of its fragments, it becomes perhaps as tenable as the second, and there would seem to be at present no means of deciding between them.

The discovery of these bodies has hitherto been affected simply by patient and assiduous search. The asteroid hunter provides himself with charts of portions of the sky about 2° square near the ecliptic, so choosing his "preserves" as to have some one of them in convenient position for observation at all seasons of the year. On the chart he marks down all the stars visible with his instrument. The principal labor lies in preparing the charts; these once made, any interlopers are readily detected, and if planets (and not merely variable stars) their motion will reveal their character in a very few hours. The only remaining difficulty is to be sure that the object is really a *new* planet, and not one of the old ones, for it has happened more than once that a discovery announced with something of a flourish has had to be given up as a mistake for this reason. Hitherto there has been comparatively little difficulty in the matter, because the "Berlin Astronomical Year Book" has published each year ephemerides of all the planets whose opposition occurs during the year. But the labor and expense of the calculations has become so great on account of the increasing number, and the results are of so little importance to general astronomy, that it has been decided to give them up partially, and the ephemerides for 1877 contains the places of only 50 out of the whole 125 which come to opposition this year. This will often render it necessary, when a supposed new planet is found, to go through a long and laborious computation in order to make sure that it is not one of those already known. It is to be expected, therefore, that unless this difficulty is somehow met the number of annual discoveries will greatly diminish.

The race between the planet hunters is frequently quite exciting. It has happened several times that the same planet has been discovered by two or more independent observers on the same evening, and both Goldschmidt and Peters have been so fortunate as to discover pairs of planets at a single sitting; the latter has done it twice.

While these planets are personally, so to speak, of trifling account, very valuable results are obtainable from the study of their motions. An excellent determination of the solar parallax has been deduced by Galle from observations on the opposition of Flora. The most reliable value of the mass of Jupiter is that derived from the perturbations he produces upon the orbits of some of them. One or two cases of great prospective interest are presented, where the orbits of two of these bodies so closely coincide as to render it quite possible that some time they may, if they do not actually collide, come to move around each other in an oval orbit like that of a double star.

Minute as they are, they are not to be despised, and it is more than probable that in some way, though as yet beyond prediction, they will repay the labor spent upon them. Very few scientific facts remain forever barren.—*Boston Journal of Chemistry.*

STRUCTURE AND ORIGIN OF METEORITES.*

The study of meteorites is naturally divisible into several very distinct branches of inquiry. Thus in the first place we may regard them as shooting stars, and observe and discuss their radiant points and their relation to the solar system. This may be called the astronomical aspect of the question. Then, when solid masses fall to the ground, we may study their chemical composition as a whole, or that of the separate mineral constituents; and lastly, we may study their mechanical structure, and apply to this investigation the same methods which have yielded such important results in the case of terrestrial rocks. So much has been written on the astronomical, chemical, and mineralogical aspect of my subject by those far more competent than myself to deal with such questions, that I shall confine my remarks almost entirely to the mechanical structure of meteorites and meteoric irons, and more especially to my own observations, since they will, at all events, have the merit of greater originality and novelty. Time will, however, not permit me to enter into the detail even of this single department of my subject.

In treating this question, it appeared to me very desirable to exhibit to you accurate reproductions of the natural objects, and I have therefore had prepared photographs of my original drawings, which we shall endeavor to show by means of the oxyhydrogen lime-light, and I shall modify my lecture to meet the requirements of the case, exhibiting and describing special examples, rather than attempt to give an account of meteorites in general. Moreover, since the time at my disposal is short, and their external characters may be studied to great advantage at the British Museum, I shall confine my remarks as much as possible to their minute internal structure, which can be seen only by examining properly prepared sections with more or less highly magnifying powers.

By far the greater part of my observations were made about a dozen years ago. I prepared a number of sections of meteorites, meteoric irons, and other objects which might throw light on the subject, and my very best thanks are due to Prof. Maskelyne for having most kindly allowed me to thoroughly examine the very excellent series of thin sections, which had been prepared for him. During the last ten years my attention has been directed to very different subjects, and I have done little more than collect material for the further and more complete study of meteorites. When I have fully utilized this material I have no doubt that I shall be able to make the subject far more complete, and may find it necessary to modify some of my conclusions. I cannot but feel that very much more remains to be learned, and I should not have attempted to give an account of what I have so far done, if I had not been particularly asked to do so by Mr. Lockyer. At the same time I trust that I shall at all events succeed in showing that the microscopical method of study yields such well-marked and important facts, that in some cases the examination of only a single specimen serves to decide between rival theories.

In examining with the naked eye an entire or broken meteorite we see that the original external outline is very irregular, and that it is covered by a crust, usually but not invariably black, comparatively thin, and quite unlike the main mass inside. This crust is usually dull, but sometimes, as in the Stannern meteorite, bright and shining, like a coating of black varnish. On examining with a microscope a thin section of the meteorite, cut perpendicular to this crust, we see that it is a true black glass filled with small bubbles, and that the contrast between it and the main mass of the meteorite is as complete as possible, and the junction between them sharply defined, except when portions have been injected a short distance between the crystals. We thus have a most complete proof of the conclusion that the black crust was due to the true igneous fusion of the surface under conditions which had little or no influence at a greater depth than $\frac{1}{100}$th of an inch. In the case of meteorites of different chemical composition, the black crust has not retained a true glassy character, and is sometimes $\frac{1}{12}$th of an inch in thickness, consisting of two very distinct layers, the internal showing particles of iron which have been neither melted nor oxidized, and the external showing that they have been oxidized and the oxide melted up with the surrounding stony matter. Taking everything into consideration, the microscropical structure of the crust agrees perfectly well with the explanation usually adopted, but rejected by some authors, that it was formed by the fusion of the external surface, and was due to the very rapid heating which takes place when a body moving with planetary velocity rushes into the earth's atmosphere—a heating so rapid that the surface is melted before the heat has time to penetrate beyond a very short distance into the interior of the mass.

INTERIOR STRUCTURE OF METEORITES.

When we come to examine the structure of the original interior part of meteorites, as shown by fractured surfaces, we may often see with the naked eye that they are mottled in such a way as to have many of the characters of a brecciated rock, made up of fragments subsequently cemented together and consolidated. Mere rough fractures are, however, very misleading. A much more accurate opinion may be formed from the examination of a smooth flat surface. Facts thus observed led Reichenbach to conclude that meteorites had been formed by the collecting together of the fragments previously separated from one another in comets, and an examination of thin transparent sections, with high magnifying powers and improved methods of illumination, proves still more conclusively their brecciated structure. The facts are, however, very complex, and some are not easily explained. Leaving this question for the present, I will endeavor to point out what appears to be the very earliest history of the material, as recorded by the internal structure.

FORMATION OF MINERALS AND ROCKS.

It is now nearly twenty years since I first showed that the manner of formation of minerals and rocks may be learned from their microscopical structure. I showed that when crystals are formed by deposition from water, or from a mass of melted rock, they often catch up portions of this water or melted stone, which can now be seen as cavities containing fluid or glass. We may thus distinguish between crystalline minerals formed by purely aqueous or by purely igneous processes; for example, between minerals in veins and minerals in volcanic lavas. In studying meteorites it appeared to me desirable, in the first place, to ascertain whether the crystalline minerals found in them were originally formed by deposition from water or from a melted stony material analogous to the slags of our furnace or the lava of volcanoes. One of the most common of the minerals in meteorites is olivine, and when met with in volcanic lavas this mineral usually contains only a few and small glass cavities in comparison with those seen in such minerals as augite. The crystals in meteorites are, moreover, only small, and thus the difficulty of the question is considerably increased. However, by careful examination with high magnifying power, I found well-marked glass cavities, with perfectly fixed bubbles, the inclosed glass being sometimes of brown color and having deposited crystals. On the contrary, I have never been able to detect any trace of fluid cavities, with moving bubbles, and therefore it is very probable, if not absolutely certain, that the crystalline minerals were chiefly formed by an igneous process, like those in lava, and analogous volcanic rocks. These researches require a magnifying power of 400 or 600 linear.

Passing from the structure of the individual crystals to that of the aggregate, we find that in some cases we have a structure in every respect analogous to that of erupted lavas, though even then there are very curious differences in detail. By methods like those adopted by Daubrée, there ought to be no more difficulty in artificially imitating the structure of such meteorites than in imitating that of our ordinary volcanic rocks. It is, however, doubtful whether meteorites of any considerable size uniformly possess this structure. The best examples I have seen are only fragments inclosed in the general mass of the Petersburg meteorite, which, like many others, has exactly the same kind of structure as that of consolidated volcanic tuff or ashes. This is well shown by the Bialystock meteorite, which is a mass of broken crystals and more complex fragments scattered promiscuously through a finer-grained consolidated dust-like ash.

Passing from this group of meteorites, which are more or less analogous to some of our terrestrial volcanic rocks, we must now consider the more common varieties, which are chiefly composed of olivine and other allied minerals. The Mezö Madaras meteorite is an excellent illustration, since the outline of the fragments is well seen, on account of the surrounding consolidated fine material being of dark color. In it we see more or less irregular spherical and very irregular fragments scattered promiscuously in a dark, highly consolidated, fine-grained base. By far the larger part of these particles do not either by their outline or internal structure furnish any positive information respecting the manner in which they were formed; but careful examination of this and other analogous meteorites has enabled me to find that the form and structure of many of the grains is totally unlike that of any I have ever seen in terrestrial rocks, and points to very special physical conditions. Thus some are almost spherical drops of *true glass* in the midst of which crystals have been formed, sometimes scattered promiscuously, and sometimes deposited on the external surface, radiating inwardly; they are, in fact, partially divitrified globules of glass, exactly similar to some artificial blowpipe beads.

As is well known, glassy particles are sometimes given off from terrestrial volcanoes, but on entering the atmosphere they are immediately solidified and remain as mere fibers, like *Pele's hair*, or as more or less irregular laminæ, like pumice dust. The nearest approach to the globules in meteorites is met with in some artificial products. By directing a strong blast of hot air or steam into melted glassy furnace slag, it is blown into spray, and usually gives rise to pear-shaped globules, each having a long hair-like tail, which is formed because the surrounding air is too cold to retain the slag in a state of perfect fluidity. Very often the fibers are the chief product. I have never observed any such fibers in meteorites. If the slag be hot enough, some spheres are formed without tails, analogous to those characteristic of meteorites. The formation of such alone could not apparently occur unless the spray were blown into an atmosphere heated up to near the point of fusion, so that the glass might remain fluid until collected into globules. The retention of a true vitreous condition in such fused stony material would depend on both the chemical composition and the rate of cooling, and its permanent retention would in any case be impossible if the original glassy globule were afterwards kept for a long time at a temperature somewhat under that of fusion. The combination of all these conditions may very well be looked upon as unusual, and we may thus explain why grains containing true glass are comparatively very rare; but though rare they point out what was the origin of many others. In by far the greater number of cases the general basis has been completely divitrified, and the larger crystals are surrounded by a fine grained stony mass. Other grains occur with a fan-shaped arrangement of crystalline needles, which an uncautious, nonmicroscopical observer might confound with simple concretions. They have, however, a structure entirely different from any concretions met with in terrestrial rocks, as for example that of oolitic grains. In them we often see a well-marked nucleus, on which radiating crystals have been deposited equally on all sides, and the external form is manifestly due to the growth of these crystals. On the contrary, the grains in meteorites now under consideration have an external form *independent of the crystals*, which do not radiate from the centre, but from one or more places on the surface. They have, indeed, a structure absolutely identical with that of some artificial blowpipe beads which become crystalline on cooling. With a little care these can be made to crystallize from one point, and then the crystals shoot out from that point in a fan-shaped bundle, until the whole bead is altered. In this case we clearly see that the form of the bead was due to fusion, and existed prior to the formation of the crystals. The general structure of both these and the previously described spherical grains also shows that their rounded shape was not due to mechanical wearing. Moreover, melted globules with well defined outline could not be formed in a mass of rock pressing against them on all sides, and I therefore argue that some at least of the constituent particles of meteorites were originally detached glassy globules, like drops of fiery rain.

Another remarkable character in the constituent particles of meteorites is that they are often mere fragments, although the entire body before being broken may originally have been only one-fortieth or one-fiftieth of an inch in diameter. It appears to me that thus to break such minute particles

* Abstract of lecture delivered by H. C. Sorby, F.R.S., etc., at the Museum, South Kensington, London, on March 10.

when they were probably in a separate state, mechanical forces of great intensity would be required. By far the greater number of meteorites have a structure which indicates that this breaking up of the constituents was of very general occurrence.

Assuming then that the particles were originally detached like volcanic ashes, it is quite clear that they were subsequently collected together and consolidated. This more than anything else appears to me a very great difficulty in the way of our adopting Reichenbach's cometary theory. Volcanic ashes are massed together and consolidated into tuff, because they are collected on the ground by the gravitative force of the earth. It appears to me very difficult to understand how in the case of a comet there could be in any part a sufficiently strong gravitative force to collect the dispersed dust into hard stony masses like meteorites. If it were not for this apparent difficulty, we might suppose that some of the facts here described were due to the heat of the sun, when comets approach so near to it that the conditions may be practically almost solar. Comets may and probably do contain many meteorites, but I think that their structure indicates that they were originally formed under conditions far more like those now existing at the surface of the sun than in comets.

The particles having been collected together, the compound mass has evidently often undergone considerable mechanical and crystalline changes. The fragments have sometimes been broken *in situ*, and "faulted;" and crystallization has taken place analogous to that met with in metamorphic rocks, which has more or less, and sometimes almost entirely, obliterated the original structure. The simplest explanation of this change is to suppose that after consolidation meteorites were variously heated to temperatures somewhat below their point of fusion. Those which have the structure of true lava may in some cases be portions which were actually remelted. We have also this striking fact, that meteoric masses of compound structure, themselves made up of fragments, have been again broken up into compound fragments, and these collected together and consolidated along with fresh material, to form the meteorites in their present condition. L'Aigle is a good example of this complex structure.

Another remarkable fact is the occurrence in some meteorites of many veins filled with material, in some respects so analogous to the black crust, that at one time I felt induced to believe that they were cracks, into which the crust had been injected. Akburfur is a good example of this, and seems to show that, under whatever conditions the veins were found, they were injected not only with a black material, but also with iron and magnetic pyrites.

METEORITES, HOW FORMED.

Taking, then, all the above facts into consideration, it appears to me that the conditions under which meteorites were formed must have been such that the temperature was high enough to fuse stony masses into glass; the particles could exist independently one of the other in an incandescent atmosphere, subject to violent mechanical disturbances; that the force of gravitation was great enough to collect these fine particles together into solid masses, and that these were in such a situation that they could be metamorphosed, further broken up into fragments, and again collected together. All these facts agree so admirably with what we know must now be taking place near the surface of the sun, that I cannot but think that, if we could only obtain specimens of the sun, we should find that their structure agreed very closely with that of meteorites.

DO THEY COME FROM THE SUN?

Considering also that the velocity with which the red flames have been seen to be thrown out from the sun is almost as great as that necessary to carry a solid body far out into planetary space, we cannot help wondering whether, after all, meteorites may not be portions of the sun recently detached from it by the violent disturbances which do most certainly now occur, or were carried off from it at some earlier period, when these disturbances were more intense. At the same time, as pointed out by me many years ago, some of the facts I have described may indicate that meteorites are the residual cosmical matter, not collected into planets, formed when the conditions now met with only near the surface of the sun extended much further out from the centre of the solar system. The chief objection to any great extension of this hypothesis is that we may doubt whether the force of gravitation would be sufficient to explain some of the facts. In any case I think that one or other of these solar theories, which to some extent agree with the speculations of the late Mr. Brailey, would explain the remarkable and very special microscopical structure of meteorites far better than that which refers them to portions of a volcanic planet, subsequently broken up, as advocated by Meunier, unless indeed we may venture to conclude that the material might still retain its original structure, due to very different conditions, previous to its becoming part of a planet. At the same time so little is positively known respecting the original constitution of the solar system, that all these conclusions must to some extent be looked upon as only provisional.

METEORIC IRON.

I will now proceed to consider some facts connected with meteoric irons. The so-called Widmanstätt's figuring, seen when some of these irons are acted on by acids, is well known; but in my opinion the preparations are often very badly made. When properly prepared, the surface may be satisfactorily examined with a magnifying power of 200 linear, which is required to show the full detail. We may then see that the figuring is due to a very regular crystallization, and to the separating out one from the other of different compounds of iron and nickel, and their phosphides. When meteoric iron showing this structure is artificially melted, the resulting product does not show the original structure, and it has therefore been contended that meteoric iron was never in a state of igneous fusion. In order to throw light on this question, I have paid very much attention to the microscopical structure of nearly all kinds of artificial irons and steels, by study surfaces polished with very special care, so as to avoid any effect like burnishing, and then acting on them very carefully with extremely dilute nitric acid. In this manner most beautiful and instructive specimens may be obtained, showing a very great amount of detail, and requiring a magnifying power varying up to at least 200 linear.

IRON AND STEEL UNDER THE MICROSCOPE.

In illustration of my subject, I will call attention to only a few leading types of structure. In the first case we have gray pig-iron, showing the laminæ of graphite promiscuously arranged in all positions, on the surface of which is a thin layer of what is probably iron uncombined with carbon, whilst the intermediate spaces are filled up with what are probably two different compounds of iron and carbon.

White chilled refined iron has an entirely different structure and more uniform crystallization, the structure is very remarkable and beautiful, mainly due to the varying crystallization of an intensely hard compound of iron and carbon, and the two other softer compounds met with in gray pig.

Malleable bar iron has an entirely different structure, and shows fibers of black slag, and a more or less uniform crystallization of iron with a varying small amount of carbon.

Cast steel differs again very much from any of the previous. It shows a fine-grained structure, due to small radiating crystals, and no plates of graphite.

The difference between any of the above and meteoric iron is extremely great.

In the case of Bessemer metal we have a crystalline structure approaching in some places more nearly to that of meteoric iron. We see a sort of Widmanstätt's figuring, but it is due to the separation of free iron from a compound containing a little carbon, and not to a variation in the amount of nickel.

The nearest approach to the structure of meteoric iron is met with in the central portion of thick bars of Swedish iron, kept for some weeks at a temperature below their melting point, but high enough to give rise to recrystallization. We then get a complete separation of free iron from a compound containing some carbon, and a crystalline structure which, as far as mere form is concerned, most closely corresponds with that of meteoric iron, as may be at once seen on comparing them.

These facts clearly indicate that the Widmanstätt's figuring is the result of such a complete separation of the constituents and perfect crystallization as can occur only when the process takes place slowly and gradually. They appear to me to show that meteoric iron was kept for a long time at a heat just below the point of fusion, and that we should be by no means justified in concluding that it was not previously melted. Similar principles are applicable in the case of the iron masses found in Disco, and it by no means follows that they are meteoric because they show the Widmanstatt's figuring. Difference in the rate of cooling would serve very well to explain the difference in the structure of some meteoric iron, which do not differ in chemical composition; but, as far as the general structure is concerned, I think that we are quite at liberty to conclude that all may have been melted, if this will better explain other phenomena. On this supposition we may account for the separation of the iron from the stony meteorites, since under conditions which brought into play only a moderate gravitative force, the melted iron would subside through the melted stone, as happens in our furnaces; whilst at the same time, as shown in my paper read at the meeting of the British Association in 1864, where the separating force of gravitation was small, they might remain mixed together, as in the Pallas iron, and others of that type.

In conclusion, I would say that though from want of adequate material for investigation I feel that what I have so far done is very incomplete, yet I think that the facts I have described will, at all events, serve to prove that the method of study employed cannot fail to yield most valuable results, and to throw much light on many problems of great interest and importance in several different branches of science.

FIFTY SYRUP RECIPES. FOR MINERAL WATERS AND OTHER PURPOSES.

THE following collection of formulas is likely to be acceptable at this season of the year:

SIMPLE SYRUP.

White sugar	14 pounds.
Water	1 gallon.

Dissolve with gentle heat in a close vessel, and strain.

LEMON SYRUP.

Grate off the yellow rind of lemons, and beat it up with a sufficient quantity of granulated sugar. Express the lemon juice, add to each pint of juice 1 pint of water, and 3½ pounds of granulated sugar, including that rubbed up with the rind; warm until the sugar is dissolved, and strain.

ANOTHER FORMULA.

Simple syrup	1 gallon.
Oil of lemon	25 drops.
Citric acid	10 drachms.

Rub the oil of lemon with the acid, add a small portion of syrup, and mix.

ANOTHER FORMULA.

Dissolve 6 drachms of tartaric acid and 1 ounce of gum arabic, in pieces, in one gallon of simple syrup; then flavor with 1½ fluid drachms of best oil of lemon. Or, flavor with the saturated tincture of the peel in cologne spirits.

MULBERRY SYRUP.

Mulberries, not entirely ripe	6 pounds.
Sugar, coarsely powdered	6 "

Place in a kettle over the fire, and boil, constantly stirring, until the boiling syrup marks 30° Baumé. Throw on a strainer, and allow the marc to drain thoroughly.

VANILLA SYRUP.

Fluid ext. of vanilla	1 ounce.
Citric acid	½ "
Simple syrup	1 gallon.

Rub the acid with some of the syrup, add the extract of vanilla, and mix.

VANILLA CREAM SYRUP.

Fluid ext. of vanilla	1 ounce.
Simple syrup	3 pints.
Cream (or condensed milk)	1 pint.

May be colored with carmine.

CREAM SYRUP

Fresh cream	½ pint.
Fresh milk	½ "
Powdered sugar	1 pound.

Mix by shaking, and keep in a cool place. The addition of a few grains of bicarbonate of soda will for some time retard souring.

ANOTHER FORMULA:

Oil of sweet almonds	2 ounces.
Powdered gum arabic	2 "
Water	4 "

Make an emulsion, and add simple syrup enough to complete 2 pints.

GINGER SYRUP.

Tincture of ginger	2 fl. ounces.
Simple syrup	4 pints.

ORANGE SYRUP.

Oil of orange	30 drops.
Tartaric acid	4 drachms.
Simple syrup	1 gallon.

Rub the oil with the acid, and mix.

PINEAPPLE SYRUP.

Use pineapples of good flavor, cut or chop them up, and set aside for 24 to 36 hours, press, and proceed as directed for strawberry syrup.

ANOTHER FORMULA.

Oil of pineapple	1 drachm.
Tartaric acid	1 "
Simple syrup	6 pints.

NECTAR SYRUP.

Vanilla syrup	5 pints.
Pineapple syrup	1 pint.
Strawberry, raspberry, or lemon syrup	2 pints.

SHERBET SYRUP.

Vanilla syrup	3 pints.
Pineapple syrup	1 pint.
Lemon syrup	1 "

GRAPE SYRUP.

Brandy	½ pint.
Spirits of lemon	½ ounce.
Tinct. of red saunders	2 ounces.
Simple syrup	1 gallon.

BANANA SYRUP.

Oil of banana	2 drachms.
Tartaric acid	1 drachm.
Simple syrup	6 pints.

COFFEE SYRUP.

Coffee, roasted	½ pound.
Boiling water	1 gallon.

Enough is filtered to make one half gallon of the infusion, to which add

Granulated sugar	7 pounds.

ANOTHER FORMULA.

Ground Java coffee	2 ounces.
Simple syrup	2 fl. ounces.

Mix and pack in a percolator, and add, boiling hot, a mixture of

Loaf sugar	12 ozs. avdp.
Distilled water	8 fl. ounces.

To percolate 1 pint of syrup.

WILD CHERRY SYRUP.

Wild cherry bark (in coarse powder)	5 ounces.

Moisten the bark with water and let it stand for 24 hours in a close vessel. Then pack it firmly in a percolator, and pour water upon it until one pint of water is obtained.

To this add

Sugar	28 ounces.

WINTERGREEN SYRUP.

Oil of wintergreen	25 drops.
Simple syrup	5 pints.
Burnt sugar (to color)	q. s.

SARSAPARILLA SYRUP.

Oil of wintergreen	10 drops.
Oil of anise	10 "
Oil of sassafras	10 "
Fluid ext. of sarsaparilla	2 ounces.
Simple syrup	5 pints.
Powdered ext. of licorice	½ ounce.

ANOTHER FORMULA (PARRISH'S).

Simple syrup	4 pints
Comp. syrup sarsaparilla	4 fl. ounces.
Caramel	1½ "
Oil of wintergreen	6 drops.
Oil of sassafras	6 "

MAPLE SYRUP.

Maple sugar	4 pounds.
Water	2 pints.

CHOCOLATE SYRUP.

Best chocolate	8 ounces.
Water	2 pints.
White sugar	4 pounds.

Mix the chocolate in water, and stir thoroughly over a slow fire. Strain, and add the sugar.

ANOTHER FORMULA.

Bark of roasted cacao bean	2 ounces.

Reduce to a moderately fine powder, mix with

Simple syrup	2 ounces.

Pack in a percolator, and exhaust with the following menstruum at a boiling temperature;

Sugar	12 ounces.
Water	8 "

So as to obtain 1 pint of syrup. To the percolate add, when cold,

Extract of vanilla	2 fl. drachms.

COFFEE CREAM SYRUP.

Coffee syrup	2 pints.
Cream	1 pint.

AMBROSIA SYRUP.

Raspberry syrup	2 pints.
Vanilla syrup	2 "
Hock wine	4 ounces.

HOCK AND CLARET SYRUP.

Hock or claret wine	1 pint.
Simple syrup	2 pints.

SOLFERINO SYRUP.

Brandy	1 pint.
Simple syrup	2 pints.

CAPSICUM SYRUP.

Tinct. of capsicum	1 ounce.
Simple syrup	2 pints.

Heat the syrup, add the tincture, and, when the alcohol has evaporated, mix immediately.

CHERRY SYRUP.

Take sour cherries, a convenient quantity, bruise them in a porcelain, stone, or wood mortar, to break the stones or pits of the fruit; express the juice, set it aside for three days to undergo fermentation, and proceed according to the directions given for strawberry syrup.

STRAWBERRY SYRUP.

Use strawberries of a good flavor; do not forget that, if the berries possess no flavor, you cannot expect to obtain a syrup of fine flavor. Avoid, also, rotten berries, because, unless you do, you may be sure to find as flavor the smell of the rotten berries in your syrup. Mash the fruit in a barrel, or other suitable vessel, by means of a pounder, and leave the pulp for 12 or 24 hours at a temperature between 70° and 80°; stir occasionally, press, set the juice aside for one night, add for every pound avoirdupois of juice 1 ounce avoirdupois of Cologne spirit or deodorized alcohol; mix, set aside for another night, and filter through paper.

For 1 pound of the filtered juice, take 1¾ pounds of A sugar, and heat to the boiling point taking care to remove from the fire or turn off the steam as soon as the mixture begins to boil; remove the scum, and bottle in perfectly clean bottles, rinsed with a little Cologne spirit.

This syrup, as well as those made by the same process, is strong enough to be mixed with two or three times its weight of simple syrup for the soda fountain.

RASPBERRY SYRUP.

Proceed as directed for strawberry syrup.

RASPBERRY SYRUP (ARTIFICIAL).

Orris root (best)	1 ounce.
Cochineal	2 drachms.
Tartaric acid	2 "
Water	2 pints.

Powder the orris root coarsely together with the cochineal, infuse in the water with the acid for 24 hours; strain, and add 4 pounds of sugar, raise to the boiling point, and strain again.

PEACH SYRUP.

Proceed in the same manner as for strawberry syrup.

BLACKBERRY SYRUP.

Prepare like either strawberry or mulberry syrup.

ORGEAT SYRUP.

Sweet almonds	8 ounces.
Bitter almonds	2½ "
Sugar	3 pounds
Water	26 ounces.
Orange flower water	4 "

Blanch the almonds, rub them in a mortar to a fine paste with 13 ounces of the sugar and 3 ounces of the water. Mix the paste with the remainder of the water, strain with strong expression, add the remainder of the sugar, and dissolve it with the aid of a gentle heat. Lastly, add the orange flower water, and strain the syrup again.

CATAWBA SYRUP.

Simple syrup	1 pint.
Catawba wine	1 "

MILK PUNCH SYRUP.

Simple syrup	1 pint.
Brandy	8 ounces.
Jamaica rum	8 "
Cream syrup	1 pint.

CHAMPAGNE SYRUP.

Rhine wine	2 pints.
Brandy	2 ounces.
Sherry	1 ounce.
Granulated sugar	3 pounds.

Dissolve the sugar without heat.

SHERRY COBBLER SYRUP.

Sherry wine	1 pint.
Simple syrup	1 "
Lemon cut in thin slices	No. 1.

Macerate 12 hours, and strain.

EXCELSIOR SYRUP.

Simple syrup	1 pint.
Syrup of wild cherry bark	4 ounces.
Port wine	4 "

FANCY SYRUP.

Vanilla syrup	2 pints.
Pineapple syrup	8 ounces.
Raspberry syrup	8 "

CURRANT SYRUP.

Proceed as for strawberry syrup.

FRAMBOISÉ CURRANT SYRUP.

Raspberry syrup	1 pint.
Currant syrup	4 pints.

CAPILLAIRE (MAIDENHAIR) SYRUP.

Maidenhair	8 ounces.
Boiling water	5 pints.
Orange flower water	4 ounces.
Sugar	sufficient.

Infuse the maidenhair in the boiling water; when nearly cold, press out, and filter the liquid, add to it the orange flower water, and dissolve it in sugar, in the proportion of 7 ounces to each 4 fluid ounces of liquid.

ORANGE FLOWER SYRUP.

Orange flower water	1 pint.
Granulated sugar	28 ounces.

Dissolve without heat.

CINNAMON SYRUP.

Oil of cinnamon	30 minims.
Carbonate of magnesia	60 grains.
Water	2 pints.
Sugar, granulated	56 ounces.

Rub the oil first with the carbonate of magnesia, then with the water gradually added, and filter through paper. In the filtrate dissolve the sugar without heat.

TO MAKE THE SYRUPS FROTHY.

To each gallon of syrup, add from 2 to 4 ounces of gum arabic, dissolved in its own weight of water.—*Druggists' Circular.*

DEUTSCHE CHEMISCHE GESELLSCHAFT, BERLIN.

APRIL.

PROF. VOGEL stated, in connection with a recent communication of E. Schunck and H. Roemer, on "Purpurin," that his experiments convinced him that light played an important part in the decoloration of an alkaline solution of purpurin when exposed to the oxidizing action of the air. Two test tubes were filled with the solution and placed in the open air by daylight, one being protected, however, by a shield of black paper. In a short time the solution in the unprotected tube was completely decolorized, while the other was entirely unaffected.

A. MICHAEL gives a "New Method of Preparing Paramido-Benzoic Acid," preferable to that of oxidation and reduction of para-nitro-toluen, hitherto used on account of the saving in time and substance. Para-tolyl-succinimid, obtained by melting together equal weights of toluidin and succinic acid, is oxidized by a dilute solution of 4 molecules potassium permanganate, and yields oxy-succinyl-paramido-benzoic acid—

$$C_6H_4(COOH)\ (CO.NH.C_6H_4.COOH).$$

This acid crystallizes in yellow needles, melts at 225°, and gives a series of crystalline salts. By treatment with fuming HCl the insoluble hydrochlorate of paramido-benzoic acid is obtained, and this, upon further treatment with Na_2CO_3 and acidifying with acetic acid, yields paramido-benzoic acid, $C_6H_4(NH_2)(COOH)$. 100 grms. of tolyl-succinimid yield 35 to 40 grms. of the pure acid by this method. An analogous compound, oxyphthalyl-paramido-benzoic acid—

$$C_6H_4(COOH)\ (CO.NH.C_6H_4.COOH,$$

insoluble, melting at 275°, was obtained in a similar manner from para-tolyl-phthalimid, and is likewise changed easily into paramido-benzoic acid.

The following communications have been received from non-resident members:

A. MICHAELIS, "On the As and P Derivatives of Benzine." By the action of chlorine on diphenyl-arsen-chloride, $(C_6H_5)_2AsCl$, several chlorine additive products have been obtained. Phenyl-arsen-chloride, $C_6H_5.AsCl_2$, yields, on treatment with Na_2CO_3, the compound $C_6H_5.AsO$, from which an oxychloride, $C_6H_5.AsCl_2O$, has been prepared, and an acid $C_6H_5.AsO_3H$. The oxide, gives with bromine, $C_6H_5.AsBr_2$, and a compound, $C_6H_5.AsO_2$, analogous to $C_6H_5NO_2$, has been obtained. The chloride yields, with $(C_2H_5)_2Zn$, $C_6H_5As(C_2H_5)_2$. Higher chlorine derivatives of $(C_6H_5)_2PCl_3$ have also been obtained. $C_6H_5.PCl_2$, by heating in sealed tubes at a high temperature, is decomposed as follows:

$$_2C_6H_5.PCl_2 = PCl_3 + (C_6H_5)_2PCl.$$

E. ERLENMEYER is of the opinion that the "Constitution of the Radical C_3H_5 in Engenol" should be expressed by $-CH_2-CH=CH_2$, and not by $-CH_2=CH-CH_3$, which he previously advocated.

F. HERRMANN has found among "The Decomposition Products of Succinyl-Succinic Ether," in addition to the hydroquinon and hydroquinon-dicarbonic acid previously described by him, also salicylic acid, the formation of which is not easy to explain.

G. GOLDSCHMIDT and G. CIAMICIAN, "On a New Method of Determining Specific Densities." Some slight improvements are made upon the system of determining volumes by the weight of the mercury expelled from the apparatus after the substance enters into the gaseous state—which Victor Meyer first proposed.

P. LAGERMARK has found the "Action of Sulphuric Acid on Acetylen" to result in the formation of croton-aldehyd, aldehyd being probably the intermediary product.

O. WITT describes his discovery of the coloring-matter "Chrysoidin," lately investigated by A. W. Hofmann, and explains his reasons for refraining from publishing the account of it. By treatment with CH_3I and C_2H_5I, he has succeeded in substituting in each case two hydrocarbon groups into the chrysoidin molecule. By a more complicated reaction four methyl groups have been introduced. With sulphuric acid he has obtained a sulphonic acid, $C_{12}H_{12}N_4.SO_3H$. The action of other acids, aqueous vapor, etc., are mentioned, none of the reactions, however, yielding noteworthy results.

W. F. HILDEBRAND and R. FITTIG, "On the Constitution of Quinic Acid." The ethylic ether of quinic acid was exposed for a long time to the action of acetic anhydride, and yielded a fine crystalline substance, ethylic tetracetyl-quinic acid, $C_6H_7(O.C_2H_3O)_4COOC_2H_5$, melting at 135°, and subliming without suffering decomposition. Quinic acid was further exposed to the action of HBr in sealed tubes at 130°, and was decomposed into benzoic acid and protocatechuic acid—

$$_2C_6H_7(OH)_4COOH = \\ = C_6H_5COOH + C_6H_3(OH)_2COOH + 6H_2O,$$

a reaction similar to that taking place with mucic acid. These two reactions show that quinic acid is to be considered as the monobasic, pentatomic acid of hexa-hydro-benzine.

A. BANTLIN finds that by the "Action of Concentrated HNO_3 on Meta-nitro-phenol," as well as on the two isomeric dinitro-phenols, styphnic acid (trinitro-resorcin) is produced.

M. TRAUBE, in the course of a study "On Alcoholic Ferments in Media free from Oxygen," has obtained results confirmatory of Pasteur's experiments, showing that there are organisms that can exist without oxygen, but refuting Pasteur's opinion that the necessary oxygen is derived from the sugar used in the experiments. Their existence is found to depend on the albuminous nourishment present.

R. FITTIG, "On the so-called Non-saturated Compounds." Oil of camomile yields by distillation, isobutyric acid, angelic acid, and tiglic acid, the latter two being divided by means of the calcium salt. The additive compounds of these two acids with Br_2 and BrH have also been examined, and in both cases they yield identical bodies, offering a somewhat remarkable case of isomery.

A. LANDOLT and R. FITTIG, "On the Relations between Fumeric Acid and Maleic Acid, and between Citraconic Acid and Mesaconic Acid." The authors have ascertained that each pair of acids yields, with bromine, two distinct derivatives, while the additive compounds formed with hydrogen, and hydrogen acids are identical. These facts are, however, consistent with the adoption of the formulæ HOOC.C.CH_2.COOH, and HOOC.CH.CH.COOH for fumaric acid and maleic acid, and corresponding formulæ for the other two.

F. BINDER, "Additive Derivatives of Cinnamic Acid." Two of these compounds yield interesting reactions, Hydro-bromo-cinnamic acid and hydriodo-cinnamic acid are changed chiefly into phenylic lactic acid, on boiling with water. Treatment with Na_2CO_3 changes the acids almost completely into styrol—

$$C_6H_5.CH_2.CHBrCOONa = C_6H_5.CH_2.CH + NaBr + CO_2.$$

O. KRAFFT, by heating terpenylic acid, has obtained a "Teracrylic Acid," $C_7H_{12}O_2$, homologous with pyroterebic acid. It is a colorless liquid, boiling at 216°. In addition to terebic acid and terpenylic acid, the author has obtained another new acid by the oxidation of turpentine oil, which crystallizes finely and melts at 163°.

P. GRIESS, "Researches on Diazo Compounds." The author describes the property of diazo bodies of forming peculiar double compounds with tertiary amines. These derivatives are all strong coloring matters, and differ so entirely from the compounds with primary and secondary amines, in physical and chemical properties, that an entirely different structure is ascribed to them. Azo-benzine-diethyl-amido-benzoic acid is deposited at once in the form of large red crystals, when a solution of diazo-benzine nitrate is poured into a cold solution of meta-diethyl-amido-benzoic acid. It possesses acid properties, and corresponds to the formula—

$$C_6H_5.N.N.C_6H_3(C_2H_5)_2N.COOH.$$

Several analogous compounds, containing substituted methyl groups, sulphonic groups, etc., are described. Theoretical considerations on the constitution of the compounds derived from the union of diazo bodies with primary and secondary amines follow.

P. P. BEDSON finds that, by the action of HNO_3 on para-bromo phenyl-acetic acid, "Two Isomeric Bromo-nitro-phenyl-acetic Acids" result. They are easily separated by means of the varied solubilities of the salts. By oxidation to a known bromo-nitro-benzoic acid, one is shown to be para-bromo-phenyl-ortho-nitro-phenyl-acetic acid: the other para-bromo-ortho-nitro-phenyl-acetic acid, is entirely decomposed by oxidizing agents.

R. GNEHM and K. FORRER prepare a "Toluen-disulphonic Acid" by introducing small portions of toluen gradually into a flask in which solid sulphuric acid is in the melted condition, and then maintaining the temperature at 180° for two hours. It is identical with a-disulphonic acid obtained by Senhofer in closed tubes, by the action of sulphuric acid and phosphoric acid on toluen.

L. MEDICUS, "On Glyoxalyl Carbamid." The author shows the formula previously proposed for this body to be correct, by the quantitative determination of the decomposition products resulting from the action of KOH, and regards glyoxalyl carbamid as identical with allanturic acid and santanuric acid.

A. ATTERBERG, "On a Derivative of Naphthalen." The author communicates some confirmatory proofs to his previous researches in this direction (*Chem. News*, vol. xxxiv., p. 270). The two Cl atoms in B-dichloro-naphthalen are shown to be in the same half of the naphthalen molecule by the formation of a-dichloro-phthalic acid, through the action of HNO_3. By the same treatment the two Cl atoms in y-dichloro-naphthalin are found to be in separate halves of the molecule. The author deduces, from his investigations on the dichloro-naphthalens additional evidence for the symmetrical form of the naphthalen molecule.

A. CLAUS and G. STEIN have obtained by the "Action of Sodium on Epichlorhydrin," an alcohol, $C_6H_{10}O_2$, forming additive compounds with Br and HCl. The authors find, also, that the small yield of epichlorhydrin by the treatment of dichlorhydrin with caustic alkalies, is due to the regeneration of glycerin during the process, half the substance employed undergoing this change.

A. CLAUS and H. POPPE, "On Mellitic Acid." This is easily obtained pure in large quantities, direct from mellite, by digesting the finely pulverized mineral for several hours with concentrated ammonia. The filtered solution is evaporated to dryness and heated to 130°, at which temperature the humates are decomposed or changed into insoluble forms. The aqueous extract of the residue forms a colorless solution of pure ammonium mellicate, from which the acid is obtained by the usual method with Pb and H_2S. The authors find it impossible by the action of Zn and C_2H_5I on the ethylic ether, to reduce one of the carboxyl groups to $-C(OH)(C_2H_5)_2$, as is the case with oxalic ether. Oxalic acid appears to stand alone in this respect among dibasic acids. A great similarity is noticed between the hexabasic mellitic acid and the tribasic phosphoric acid. Several acid and double mellitates analogous to the phosphates have been prepared.

A. LADENBURG responds to the recent criticisms of V. Meyer on his researches "On Ammonium Compounds," adducing proofs to show the purity of his substances and the differences between the isomeric substituted ammonium compounds obtained by him.—*Chemical News.*

PRACTICAL RECEIPTS.

ELSNER'S GREEN.

A GREEN free from arsenic may be prepared as follows: Make, on the one hand, a solution of sulphate of copper, and, on the other, a decoction of fustic, which is clarified by the addition of about 1 per cent. of glue, dissolved in water, and allowed to settle. The clear liquor is then added to the solution of sulphate of copper, the liquid is mixed with 10 to 12 per cent. of tin crystals, and caustic soda lye is added till all the copper is precipitated. A small excess of soda gives it a more blue cast. The color turns more to the blue on drying. The more decoction of fustic is used the yellower is the green.

A given shade can be produced with greater certainty by first preparing a yellow lake from the fustic, with tin crystals and soda. In another vessel Bremen blue is prepared and washed. The yellow lake and the Bremen blue, both stirred up in water, are then mixed, till the required shade is exactly hit: the whole is then washed once more, filtered and dried.

This color is less fiery than the dangerous arsenical greens, but surpasses green ultramarine. It is not sensitive to light, but is easily affected by damp and vapors of sulphur. It may be used as a water or an oil color, or along with lime.

BREMEN BLUE.

The blue vitriol used in the process must be perfectly free from iron, otherwise the color will be dull an impure.

A solution of the blue vitriol and a caustic soda lye are then prepared, both at 15 deg. Baumé. The former is placed in a copper pan, and heated to about 78 deg. to 100 deg. F. Room must be left for sufficient alkaline lye to precipitate the solution. The lye is placed in a wooden or iron vessel, with a plug for running off the lye at pleasure. This vessel is placed over the copper pan, and as soon as the temperature is reached, the plug is opened, and the lye is allowed to flow out in a thin stream into the copper solution, stirring all the time, till the liquid is completely decolorized. No excess of lye must be added, and the temperature must not be allowed to rise higher, or blackening may ensue. We may ascertain when sufficient lye has been added, by filtering a small sample off from the precipitate. If enough lye has been added, the liquid will be as clear as water, and will give no further precipitate with an addition of more lye. The precipitate, which now appears green, is taken out and washed, and drained upon filters till it become a thick paste. It has now to undergo the process of "blueing." For this purpose a potash lye is prepared, not perfectly caustic. This is effected by dissolving in an ordinary caustic lye, at 17 deg. Baumé, so much crude potash that it may mark 22 deg. to 25 deg. Baumé. It is allowed to settle, and is then fit for use. The blueing is performed in copper pans, which should be movable. About 50 lbs. of the green precipitate may be placed in the pan, and about half a small pail of the lye is poured upon it, and immediately stirred well with a wooden spatula. The mixture takes a more blue color, which change goes on for some time. A small sample is placed upon paper, and the color examined. Another small portion is put in a glass, a little caustic lye is added, stirred up, and compared again, and a few drops are placed upon the same paper. If the color of the first sample is satisfactory, or if a further addition of lye produces no more decided blueness, sufficient lye has been added. If, however, a bluer shade appears in the sample, more lye—say ¼ pail—is added to the bulk, and stirred up, testing again till the full blue shade has been reached. The contents of the copper pan are then emptied into a cistern containing a very large excess of water, and washed repeatedly by decantation, so stirring until every trace of caustic lye and alkaline salt is removed. If this is not done the color will become blackened in spots on drying. When the washing is completed, the color is strained through cotton cloths, pressed in cakes about 1½ inch in thickness, and then cut into pieces 2 inches square. These are then carefully dried at first at a temperature not exceeding that of the atmosphere, finishing off at about 100 deg. F.; 100 lbs. blue vitriol, with 100 lbs. potash, will yield in this manner 38 to 39 lbs. of color.

WILD YELLOW LAKE.

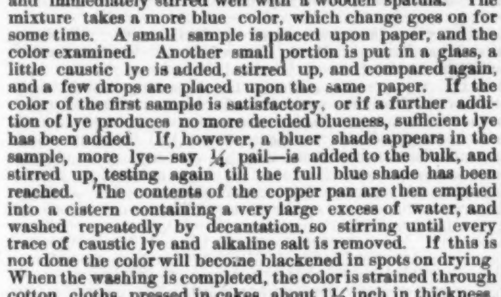
Take any quantity of the clear decoction, dissolve in it a little alum (free from iron), and then precipitate with soda, carbonate of soda, or, better still, with tin crystals. The lake is a pure yellow, without any orange cast. The color, however, is not permanent, and gradually fades on exposure to light.—*Chemical Review.*

A NEW OXYGEN RETORT.*

By WILLIAM J. CHADWICK.

THE oxygen mixture is in the form of perforated cakes, instead of plugs or cylinders. The shape of the retort is made so that the cake lies upon the bottom, and is only in contact on that side. The cakes, with the bottom bearing on the retort, consist simply of manganese, sand, or other substance containing no chlorate of potash, upon the top of which is placed the oxygen mixture, still forming one compact cake.

The retort consists of two small iron castings, the bottom one a flat, circular plate, with two projecting lugs. The



upper portion, which is bell-shaped, is made a little larger inside than the cakes to be used, and is attached to the bottom portion by means of a bayonet joint, although other fastenings may be adopted. The gas-tight joint between the two portions is easily made by grinding the two surfaces together, after having turned them to something like the shape. The stand simply supports the retort over an ordinary Bunsen burner, and may be attached to the top of the gas-holder, hung upon the side, or placed upon a convenient table, or even on the floor.

From the bent tube on the top portion of the retort an india-rubber or flexible pipe conveys the gas direct to the gas-holder. A small wash bottle may be used, or an ordinary back pressure valve, or an ordinary tap.

The object of using cakes of the above description is that they leave the retort perfectly clean; for, as it is the chlorate of potash that fuses and sticks to the retort, the manganese or sand which forms the bottom of the cake, and is the only portion in direct contact with the retort, is a sure means of preventing any sticking. This plan I also adopted in the case of plugs or cylinders. The perforation of the cakes is simply to facilitate the generation of the gas.

PREPARATION OF PURE BISMUTH.

ACCORDING to Thürach, pure bismuth may be obtained by the following method: Commercial bismuth is melted under a surface of potassium chlorate to which from two to five per cent. of sodium carbonate had previously been added; the quantity depending upon the amount of impurities in the bismuth. The resulting regulus is dissolved in the least quantity of nitric acid. The solution is to be mixed with a concentrated solution of oxalic acid in slight excess, and then considerably diluted. After the precipitate has settled, it is separated from the clear liquid by decantation and filtration and washed with cold water. If the precipitate is allowed to remain too long in contact with the supernatant liquid, it is likely to become contaminated with iron; but the subsequent ignition of the dry precipitate again removes this impurity. By ignition the oxalate splits into metal and carbonic acid. In presence of iron there is formed a bismutho-ferric oxide, which may be completely separated from the metal by hydrochloric acid. The chief aim of the author was to devise a process which would remove iron and silver as completely as possible, but traces of the latter metal may still remain.—*Schweiz. Woch.*

*Read before the Manchester Photographic Society.

TREATING LUBRICATING OILS.

HERETOFORE it has been necessary to mix hydrocarbon, or mineral lubricating oil, with a considerable proportion of fatty oils, to give it the necessary body, or viscidity; but these fatty oils (both animal and vegetable) are all more or less oxidizable in the air, producing gummy matters becoming very acid, and if left in warm places on cotton, wool, clothes, sawdust, or similar material, are exceedingly liable to spontaneous combustion. For lubricating the pistons of high-pressure compound surface-condensing engines, both marine and stationary, the fatty oils are particularly objectionable, for, in addition to the before-mentioned faults, the high-pressure steam decomposes them into fatty acids, and glycerin, which are, of course, carried into the boilers, where the fatty acids corrode most powerfully, and with the glycerin make a kind of soapsuds, producing excessive priming. But Mr. Humfrey, of Chester, England, claims that he is able to produce mineral or hydrocarbon lubricating oil of such a body that no mixture of fatty oils whatever is required, the viscidity being equal to the best olive, and considerably superior to sperm; while being perfectly neutral, it cannot act on or corrode the condensers or boilers, nor form concretions in the cavities of the pistons and steam passages; nor does it act on the india rubber valves of the air pumps to any injurious extent when used for internal lubricating of steam engines. For ordinary lubricating it is perfect, as it forms no gum or acid, and it is absolutely safe from spontaneous combustion, with a lubricating power equal to sperm. The oil treated by his invention is also specially suited for lubricating fast-running machinery, and for all kinds of fast-running mechanism. He first submits the oil to careful fractional distillation, and collects the heavy portion of the product. In the refining or chemical treatment, instead of agitating the chemicals with the oil by means of paddles, screws, or other mechanical means, as have heretofore been used, he forces a large stream of compressed air through a pipe at or near the bottom of the vessel, by which very important advantages are obtained. As well as a most thorough and complete agitation, a considerable effect is produced, powerfully aiding the action of the chemicals used; at the same time, the great volume of air passing through carries off all traces of oils of low gravity and boiling points, the result being lubricating oil possessing more body and higher specific gravity and flash point than any mineral lubricating oils heretofore produced, making it specially adapted for lubricating the pistons, slide valves, and other parts of steam engines, machinery, and other apparatus. The oil may be produced from coal, shale, peat, bitumen, asphaltum, petroleum, and other oil producers, as is found most economical and convenient.

ESTIMATION OF BORACIC ACID.

AN easy and practical method for the determination of boracic acid, which has long been a desideratum, appears to have been supplied by Mr Paul Berg, an abstract of whose method we give in the following: It having been observed that the addition of strong alcohol to a solution of boracic acid or a borate, which has been partially precipitated by baryta, causes the complete separation of barium borate, there only remained the necessity to find an acid which would form both a sodium and a barium-salt soluble in alcohol. Such an acid was found to be bromhydric acid, since NaBr, as well as $BaBr_2$, are easily soluble in 95 per cent. alcohol, and having the additional advantage that sodium borate is easily decomposed by it into sodium bromide and hydrated boracic acid.

Finely powdered borax is dissolved in hot water, introduced into a flask, colored with a little tincture of litmus, and enough bromhydric acid is added to produce an acid reaction. There is then in solution, sodium bromide, boracic acid, and the excess of bromhydric acid. The flask is now closed with a doubly perforated cork, carrying a tube filled with pieces of caustic potassa, to absorb any carbonic acid which might be carried in by the air,* and a small funnel, containing a moistened filter. Cold saturated baryta-water is passed through the latter into the flask, until, after gently shaking, the precipitate which forms at first is redissolved. Freshly boiled alcohol of 95 per cent. is now poured in through the same funnel, so as to produce an alcoholic solution of about 55–60 per cent. in the flask, the potash tube and funnel are removed, and replaced by short glass-rods, the flask is shaken and then set aside for 24 hours. The glass rods are then again removed, the potash tube inserted into one of the perforations, and a syphon tube into the other, by means of which most of the clear liquid may be removed. Alcohol of 75 per cent. having been rapidly poured in after removal of the syphon, the flask is again hermetically closed and set aside. When the sediment has been deposited, the liquid is removed in the same manner, the sediment, consisting of barium borate transferred to a tarred filter, and washed with alcohol of 75 per cent., taking care to prevent free access of air, except towards the end. The filter and precipitate are finally dried in the exsiccator and weighed as barium (mono-) borate; BaO, B_2O_3+4 aq.—*Zeitsh. f. anal. Chem.*

EXPLOSION OF NITRO-HYDROCHLORIC ACID.

AT Bow Street Police Court, London, recently, Messrs. Rouch & Co., who were represented by their manager, Mr. G. H. Turner, were summoned for having sent out a dangerous explosive liquid, and causing damage to a tablecloth and other property in chambers occupied by Captain Hawley Smart, at St. Martin's Chambers, Trafalgar Square.

Mr. Montagu Williams, in support of the summons, said that the matter had been taken up on public grounds by Captain Smart, a gentleman in the military service, but also well known as an author and novelist. If he had been pursuing his literary occupations at the time of the explosion he might have been deprived of his eyesight or otherwise injured for life. It appeared that on the morning of the 9th April, a boy delivered at the chambers a small packet, resembling a medicine bottle. There was no address written on the bottle, and the boy was unable to say for whom it was intended. The landlady, Mrs. Billingham, thinking that it must be for Captain Smart, desired the servant to place it on that gentleman's table, and it was left there till the return of the captain between 10 and 11 at night.

Captain Smart deposed that he saw the packet lying on his table. He looked at it for a moment, and then sat down in front of the fire with his back towards the table. Suddenly he was startled by a loud explosion, like the bursting of a soda-water bottle, and he saw that the packet on the table had disappeared. The room was filled with smoke and a suffocating vapor, causing him to open the doors and windows, and as both the tablecloth and table appeared to be burning, he procured a wet cloth and took other means to prevent the spreading of fire. He found that the bottle had been splintered to atoms, and the neck of it, with a cork still in it, was found upon the floor. Stains caused by the contents of the bottle were to be seen on the carpet, the furniture, and a portion of his own wearing apparel, and he burnt one of his fingers through taking up a fragment of the bottle. The label of Messrs. Rouch was still adhering to the bottle. He sent to them for an explanation of the matter, but they treated the inquiry with such nonchalance, not to say rudeness, that he resolved to place the matter in the hands of his solicitors.

Mr. G. H. Ogston, analytical chemist, of Mincing Lane, described the mixture as a most dangerous one, stronger than nitric acid, and more destructive than vitriol. It was known as *aqua regia*, and was a combination of nitric and hydrochloric acids, and he was surprised that any chemist could have sent out such a preparation without a proper description of it, and a caution as to its dangerous character written outside.

The defence was that the mixture had been made up from the prescription of a medical man, and, when sent out by the boy, was accompanied by proper instructions, the prescription, and the address of the gentleman for whom it was prepared, viz., Major Furlong, who resided in another set of chambers under the same roof as Captain Smart. It happened that the boy neglected to deliver the prescription, etc., and address. With respect to the statement that the clerk of Messrs. Frere, complainant's solicitors, was treated with insolence by Mr. Rouch—who said that it was an attempt to extort money, and that he was as "smart" as the complainant—it was alleged that the complainant and his solicitors behaved in a very "bumptious manner," and that Mr. Rouch consequently lost his temper. It was urged that the occurrence was merely accidental, and that there being no willful intention the complainant could not be sustained; but Mr. Flowers remarked that such an explosion would probably have happened in Major Furlong's chambers with similar or worse results. The defendant said if the instructions had been delivered with the bottle it would have been seen that the bottle was to be kept in an upright position, and the defendant's boy was called to prove that he lost the paper at the time, but finding it afterwards, delivered it the next morning.

Mr. Flowers said that there had been great carelessness, and fined the defendants 40s. and £3 12s. 6d., the amount of damage done by the explosion.—*London Times.*

* The necessity of excluding carbonic acid arises from the subsequent presence of free baryta in the liquid, which might be converted into carbonate, and thereby contaminate the precipitated borate.

SYNTHESIS OF UREA.

IT has been noticed by E. Schmidt (*Ber. deut. chem. Gesell.*, 1877), that carbonic oxysulphide, as occurring in the thermal spring of Harkány, when passed into a concentrated aqueous solution of ammonia at 0° C., is absorbed in large quantities. Ammonium oxysulphocarbamate is formed,

$$COS + 2NH_3 = COSN_2H_6,$$

which after exposure for some time to ordinary temperatures, or by the application of heat, breaks up, partly into urea and sulphuretted hydrogen:

$$COSN_2H_6 = CH_4N_2O + H_2S;$$

while another part, combining with water, forms carbonate of ammonia and ammonium sulphide:

$$COSN_2H_6 + H_2O = CO_2 + 2NH_3 + H_2S.$$

The second reaction is reduced to a minimum if the liquid be treated without delay with freshly prepared lead oxide; as a lecture experiment, the liquid may be at once evaporated without the employment of the metallic oxide. Crystals of urea more than an inch in length can readily be formed by this means.

ON FORMATION OF SALTPETRE BY ORGANIC FERMENTS.

IT is commonly accepted that the nitrates distributed in the ground arise from combustion of ammonia and nitrogenous substances of organic origin; but no very definite ideas have been acquired regarding the mechanism of this combustion. Is the saltpetre formation the result of a direct and purely chemical reaction between the oxygen and the nitrogen compounds? Does it occur under the co-operation of organisms which act as ferments, or simultaneously by both these processes? "These questions arose," said MM. Schloering and Muntz (in a recent note to the French Academy), "after M. Pasteur had proved that certain organisms, such as the mycoderma of wine and vinegar, have the property of conveying the oxygen of the air to the most various organic substances, and are the most active agents for the destruction of organized material which has ceased to live. On the other hand, M. Pasteur shows that organic substances, which are at least as decomposable as those which form saltpetre in the ground, offer a remarkable resistance to oxygen, when they remain protected from all organic germs. These two facts led to the supposition that, at least in the cases of rapid combustion and formation of saltpetre, organic agencies are operative; while at the same time it may be allowed that oxygen is capable by its chemical and physical force, of consuming nitrogenous substances, and transforming them into saltpetre."

Starting from this stand-point, the authors made experiments which appear to support the supposition referred to, without absolutely demonstrating its correctness.

In the course of an investigation as to whether humus must be present in the ground in order that drainage water may be purified, *i.e.*, that the substances dissolved in it may be fully consumed, a wide glass tube 1 meter in length was filled with 5 kilogrammes of quartz sand that had been strongly heated, and was mixed with 100 grammes of powdered lime. The sand was sprinkled daily with equal quantities of drainage water, which was so calculated that the liquid took eight days to percolate through the tube. During the first twenty days there was no trace of saltpetre formation, and the quantity of ammonia in the filtered water remained unaltered; then saltpetre appeared, and as its quantity quickly increased, it was soon evident that the drainage

water on exit from the apparatus no longer contained any trace of ammonia. "If in this experiment," say the authors, "the organic substances and the ammonia were consumed by the oxygen acting directly and without aid, the question would have to be answered, why it was twenty days before the combustion commenced? This delay, however, is readily intelligible on the supposition of organic ferments, which evidently could only act after the sowing and development of their germs."

The experiment, begun in July, had lasted four months, when it was resolved to try the effect of chloroform vapors on the process. M. Muntz had found that chloroform arrests the action of organic ferments without affecting that of the soluble; the substance might thus serve to decide the question. On the sand in the tube, therefore, was placed a small vessel with chloroform, the vapors of which were driven by a powerful air current into the tube. Since, from the arrangement of the experiment, only so much drainage water was daily added that it took eight days to traverse the sand, it was not to be expected that the saltpetre would have disappeared by the next day. But after ten days the water flowing out contained no longer any trace of nitrate, while the ammonia of the canal water was all present. On evaporation, the liquid left behind a colored and smelling residuum, such as is given by filtered but unpurified drainage water.

After the chloroform vapor had acted fifteen days (27th Nov. to 12th Dec.) on the tube, the vessel was removed. During the next fifteen days the liquid flowing out of the tube still had the characteristic chloroform smell; towards the end of December the smell was gone; but during the whole of January, though the tube remained at a mean temperature of 15 deg. C., there was no trace of saltpetre. Doubtless the saltpetre-forming organisms were all dead, and the drainage water brought no new germs with it. On the 1st of February a sowing of such germs was tried; 10 grammes of an earth which was known to have the saltpetre-forming property was distributed in the water, and shaken on the sand of the tube. The saltpetre appeared exactly on the expected day, the 9th of February, and it steadily increased in quantity thereafter.

The problem remains of finding out and isolating the saltpetre-forming organisms, and MM. Schloering and Muntz have some hope of being able to solve it, following the path marked out by Pasteur for such researches.

With regard to the cleansing of drainage water, the experiment proves that a sandy, absolutely infertile soil, containing lime, may be used as an excellent purifier. In vegetable earth the saltpetre-forming agencies are in full operation; the purification of the drainage water takes place on the first day of the percolation. In an absolutely sterile ground, the purification is delayed till these agencies are developed. Herein probably lies the principal difference of these two kinds of ground, with reference to purification of drainage water.

DENSITY OF ALUM SOLUTIONS.

The following table will be found useful for ascertaining the percentage of alum present in solution by simply taking the specific gravity with a hydrometer:

POTASH ALUM.	Specific gravity.	AMMONIA ALUM.	Specific gravity.
1 per cent	1·0065	1 per cent	1·0060
2 " "	1·0110	2 " "	1·0109
3 " "	1·0166	3 " "	1·0156
4 " "	1·0218	4 " "	1·0200
5 " "	1·0269	5 " "	1·0255
6 " "	1·0320	6 " "	1·0305

It will be noticed that a solution of ammonia alum has a slightly lower specific gravity than one of potash alum containing an equal quantity of the salt.—*O. Schluttig, in Deutsche Zeitung.*

New Method of Manufacturing Sulphides, Carbonates, and Alkaline Sulpho-Carbonates.—M. C. Vincent.—If we dissolve an equivalent of sulphate of potassa in boiling water and gradually drop into it, whilst continually stirring, sulphide of barium, in quantity sufficient to furnish an equivalent of real sulphide, we obtain a solution containing an equivalent of sulphide of potassium, whilst the sulphate of baryta formed is precipitated and may be removed by filtration. If the quantities are correctly proportioned, neither sulphide of barium nor sulphide of potassa remains in solution. If we take the liquid thus obtained in place of water to dissolve a fresh quantity of sulphate of potassa, we may thus by a new addition of sulphide of potassium obtain a more concentrated solution of potassium sulphide. This solution, if treated with carbonic acid, yields carbonate of potassa, which remains in solution, while the sulphur is evolved in the state of sulphuretted hydrogen. If the solution of sulphide of potassium is agitated in a closed vessel with bisulphide of carbon, and heated to about 50°, sulpho-carbonate is obtained containing 15 per cent. of bisulphide of carbon.

THE FERMENTS CONTAINED IN PLANTS.

By C. Kosmann.

There appears to exist in the buds of trees and young leaves of many plants a natural ferment which is capable (1) of transforming cane-sugar into glucose; (2) of converting starch into dextrin and glucose; and (3) of resolving a glucoside, such as digitalin, into glucose and digitaliretin. The method adopted to show the presence of the ferment was as follows: The buds or young leaves were chopped and macerated in cold water; after twelve hours the liquor was strained off, filtered, and a portion warmed with Fehling's solution to see if any precontained glucose was present; 1·5 to 4·0 grams of sugar were then added, and the solution allowed to remain for some hours at a temperature of 18° to 30°. Generally at the end of twenty-four hours the whole of the sugar was inverted, and a syrup of glucose could be obtained by evaporation, which had a powerfully reducing action upon the copper solution. Instead of sugar, starch-paste was some times used, which, when acted upon, was converted as above mentioned. No gas was evolved in these experiments; on the contrary, oxygen was absorbed: a microscopic examination of the deposits which occurred also revealed the presence of much organic life.

The ferment was proved to exist in the following plants: Buds of *Ulmus campestris, Populus nigra, Quercus pedunculata*, and *Corylus avellana*; in the flowers of *Cornus sanguinea* and *Prunus spinosa*; in the young leaves of *Chelidonium majus* and *Digitalis purpurea*.

An infusion of digitalis leaves reduced a considerable quantity of digitalin on exposure to sunlight, resolving it into glucose and digitaliretin. The latter substance was collected as a precipitate, dissolved in alcohol, and submitted to suitable tests whereby it was recognized.

Extraction and Purification of the Ferment contained in Digitalis.—To a concentrated infusion of the young and fresh leaves, its own volume of strong alcohol was added. After twelve hours, the grayish-white precipitate which had fallen was collected, washed and dried. It was then redissolved in water, the solution filtered from a little insoluble matter, and again precipitated by the addition of alcohol. The white precipitate was washed with alcohol, and then dried on glass. The dry substance was grayish-white, granular, soluble in water, and was not rendered blue by iodine. Under the microscope it presented the appearance of granules adhering to one another. It possessed eminently the power of decomposing cane-sugar, starch-paste, and soluble digitalin, acting thus quite as energetically as a strong infusion of the leaves of the fresh plant.—*Jour. of Pharm.*

A NEW UREOMETER FOR CLINICAL USE.

The exact methods for the determination of urea in organic liquids are far too complex and tedious to be of more than occasional service to busy medical men, whilst the readier methods are not sufficiently accurate to be of more than approximate value. The method of estimating urea by means of a solution of sodium hypobromite, given by Hüfner, and the modification of it proposed by Russel and West, are very convenient for clinical purposes, but even these leave something to be desired on the score of accuracy.

In the *Practitioner* for January of this year, Drs. Russel and West state that they have found the hypobromous solution to decompose in hot weather more quickly than they expected, and that it is very important that it be freshly prepared.

They draw especial attention to this, and suggest that the solution be prepared in the following manner:

A solution of caustic soda is made in water, in the proportion of 100 grammes of solid caustic soda to 250 cc. of water. This solution may be made in large quantities, for it will keep good for a very long time. To part of this solution, bromine is added, in the proportion of 25 cc. to every 250 cc. of caustic soda solution *at the time it is required for use.*

With the view of simplifying the operation of ureometry to the utmost extent compatible with the necessary accuracy, M. J. G. Blackley, of London, devised the form of apparatus represented in the cut. It consists of two graduated tubes, a larger one, A, of about 75 cc. capacity, and a smaller one, B, of about 15 cc. capacity, closed by perforated india-

rubber stoppers, through which pass the tubes C and D. C is the wider of the two, and is provided with a glass stopcock. Its lower extremity, drawn to a fine point, descends about halfway into the tube B. D is a narrower tube, and ascends about halfway inside A. E is a short, slightly bent tube, passing through the india-rubber stopper into the tube A, and serving as an egress for the superfluous contents of A, which are collected in the beaker F, the whole being supported by the wooden stand GG.

The method of using the apparatus is as follows:

The tube A is filled with a solution of sodium hypobromite, and its stopper inserted. Then 5 cc. of the liquid to be examined are placed in the tube B, and its stopper (which has previously already been adjusted upon the ends of the glass tubes C and D) is inserted to the level of a scratch on the outside of the tube, the stop-cock being turned off. The apparatus is then placed in position on the stand, and the stop-cock gradually opened. The hypobromite solution flows down the tube C, decomposition takes place, and the gases evolved, ascending through the tube D, are collected in A. The superfluous hypobromite solution flows out through the tube E into the beaker F. To complete the operation, the apparatus is removed from the stand, after placing the finger over the mouth of the tube E, and agitated for a few moments. It is then replaced, and after allowing time for the froth to subside, the quantity of the gas collected is read off. After subtracting the small constant of air contained in the tube B, the remainder gives by calculation the quantity of urea present in the 5 cc. of liquid examined. Under ordinary circumstances, the whole operation may be completed in five or six minutes.

Instead of having the tube A graduated into cubic centimeters, it is convenient to have the graduation indicate at once the percentage of urea, as is the case with the tube supplied with Russel & West's ureometer.—*Journal Chem. Soc., Nov.*

Carbuncle is traced by M. Koch to the introduction of bacteria into the system by stinging-flies. They obtain the poisonous germs from putrescent carcases.

CURABILITY OF ACUTE PHTHISIS.

(GALLOPING CONSUMPTION.)

Dr. McCall Anderson, of Glasgow, in a recent clinical lecture, gave the histories of three cases of acute phthisis which terminated in recovery while under his care. All the cases followed exposure to cold and wet, and were characterized by a rapid course, with slight chills, high fever that rapidly assumed a typhoid type, rapid pulse and respiration, dry, coated tongue, costiveness, thirst, nausea, poor appetite, great weakness, with very rapid emaciation, frequent but not severe cough, mucous or rusty expectoration, delirium or stupidity and drowsiness, and profuse perspirations. The physical signs were slight dullness at the apices of the lungs, with abundant moist râles, and also dry râles over both lungs. The abdomen was not tympanitic, and there was no gurgling or iliac tenderness. The treatment consisted in iced cloths to the abdomen for half an hour every two hours, and in the internal administration of quinine gr. i., digitalis gr. i., and opium gr. ss., q. 4 h., with the view of reducing the fever; these remedies were used either alone or conjointly. The profuse sweats were checked by hypodermic injections of atropine gr. $\frac{1}{100}$, at night; in one of the cases the dose had to be increased to gr. $\frac{1}{50}$. The bowels were kept open by enemata or by oil. In order to keep up the strength of the patients, milk and soups, with brandy or champagne, were administered in small quantities at frequent intervals. In one case carbonate of ammonia was given.—*Lancet.*

Action of Hydrosulphite of Soda on the Hematosin of the Blood.—M. P. Cazeneuve.—On causing hydrosulphite to react upon hematosin (Chevreul), called also hematin by German authors, the following results were obtained: The hematosin was dissolved in boiled distilled water and rendered alkaline with ammonia, and the solution was then submitted to spectroscopic examination. The characteristic band of the alkaline solutions of hematosin was observed. But on adding one or two drops of hydrosulphite, the dichroic tint of the alkaline solution disappeared, followed by a vermilion-red tint, which might be taken for the color of a solution of oxyhemo-globin.

COLOGNES FOR THE SICK-ROOM.*

By George Leis.

There is, undoubtedly, a want felt, if not expressed, among the people as well as our practitioners, for a preparation that shall at once serve as a pleasing perfume, an antiseptic deodorizer, and a medicated cosmetic lotion.

Such a lotion the writer has endeavored to place before this Association, after having made numerous experiments, results of which are given below in as brief a form as possible.

Pharmaceutists are well aware of the fact that during the past years we have had innumerable compounds and chemicals offered as antiseptics, the merits of each being vaunted and extolled in its turn. After repeated trials of these new remedies, there is still a feeling predominant among those interested in the subject that the desideratum has not yet been acquired. Some of the best disinfectants are in themselves objectionable; they either possess a disagreeable odor, or will stain and corrode. Ferrous sulphate (copperas) and manganous sulphate, though not really offensive, are comparatively inert. Iodate of calcium prevents decomposition, but if used as a local application causes too much pain. Acetic acid or vinegar is at first grateful and refreshing, but becomes sickening. Chloride of lime (erroneously so-called) as the formula shows, Ca (OCl) Cl, is an uncertain compound, whose virtue depends wholly upon the amount of free chlorine it liberates; chlorine being an irritant, corroding gas, no one would desire to have it in a room containing articles of vertu or delicate metallic ornaments. Permanganate of potassa is also a very good disinfectant; but unless sprinkled and brought into contact with the air, is not so effective as thought, and in sprinkling the solution, it will necessarily produce stains upon everything it may come in contact with; hence this is not at all desirable. Hydrate of chloral is quite offensive, and the vapor stupefying. Carbolic acid or phenol, to which so much has been ascribed, is perhaps the best antiseptic we have in use at the present day, but its odor is intolerable to an invalid; its preparations are the less useful as they are less offensive.

I have now fully delineated the objections to the various disinfectants for the use of the sick-room. What we need, in my opinion, is a preparation that shall possess equal, if not greater, efficacy than any now in use, without irritant properties and unpleasant odor. Such a body, we hope, is to be found in salicylic acid.

Salicylic acid seems to be related, to a certain extent, with many organic disinfectants now in use, and we may, perhaps, consider the efficacy of such disinfectants to depend on their near relationship to salicylic acid. For instance, oleum gaultheriæ procumbentis (oil of wintergreen), said by some chemists to possess remarkable absorbent and deodorizing powers, consists almost entirely of methyl salicylic. Oleum spiræ ulmariæ (oil of meadow sweet), also considered of value, is generally regarded as the aldehyde of salicylic acid. Oxybenzoic acid is isomeric with salicylic acid, $C_7H_6O_3$. Salicylic acid is intimately related to the aromatic series of acids, most of which possess antiseptic properties in a greater or less degree. Carbolic acid itself may be obtained from salicylic acid by dry distillation.

Numerous experiments made recently by the writer have fully corroborated those made by others. Salicylic acid has proved itself to have undoubted properties to prevent putrefaction and check the development of organic growths and parasites. Meat, lightly covered with salicylic acid in substance, remained sweet, while similar portions, in the same atmosphere, became offensive. Meat dipped in an aqueous solution of the acid, made the strength of 5 gr. each of salicylic acid and borax to 1 ℥ of water, also remained wholesome. The putrefying process was easily arrested, in several compounds made for the experiment, by a free use of the salicylic acid.

No theory as to the manner in which salicylic acid exerts its influence has been advanced, but it probably acts as an antiferment, and in this manner annihilates the organic bodies produced by fermentation.

The following formulas are such as I have experimented with to my own satisfaction, and only hope they may prove as effectual and as satisfactory in the hands of others:

No. 1 ℞—Acidi Salicylici .... ʒ ss.
Spiritus Vini Rectificati .... f ℥ iv.
Olei Cinnamonii .... gtt. j.
" Bergamii .... gtt. xv.
Balsami Peruani .... f. ʒ ss.
Make a solution.

* Read before the American Pharmaceutical Association.

In order to make a solution of the above formula, dissolve the balsam of Peru in the spirits and filter, then adding balance of ingredients. The aromatics used in perfuming the above solution are as nearly chemically compatible to salicylic acid as practicable.

No. 2 ℞—Acidi Salicylici	gr. xx.
Olei Gaultheriæ	gt. v.
Spiritus Vini Rectificati Diluti	f ℥ ij.

Mix.

In the above recipe, in the place of olei gaultheriæ, the same amount of olei anisi may be added, which is also of itself a powerful deodorizer; and may be preferred by many. The basis of these solutions is salicylic acid, and any other combinations of odors can be added if desired which would harmonize with the salicylic acid. I give one for example:

Salicylic Acid	gr. xx.
Farina Cologne	f ℥ ij.

Mix.

Any one of the above recipes will be found adapted for use in sick chambers, to neutralize the infected atmosphere attending fevers. In typhoid fever they will neutralize the fecal evacuations, which are pre-eminently contagious. In rooms that have been closed for months, without necessary ventilation, they would destroy the microscopic fungous growths inevitably present. The lotion should be diffused in the room with the aid of a spray tube or atomizer. Its presumptive analogy to benzoic acid would suggest its application as a cosmetic, the lotion to be added to the water used for ablution. A dilution applied to erysipelas is productive of ease to patients. Its balsamic properties promote the healing of cuts and sores, besides freeing them from morbid atmospheric influences.

I hope I have shown the many advantages and powers of salicylic acid over other disinfectants to the entire satisfaction of the readers.

Although owing to the comparatively high cost of salicylic acid, it would possibly not be brought into general use, yet for minor purposes of disinfection its introduction in such a form will doubtless be met with a fair demand.

The name of such a preparation might be appropriately called *Lotio Antiseptica Fragrans* (Fragrant Antiseptic Lotion), which, in my opinion, gives the properties of the lotion in its name.

A NEW SOLVENT FOR SILK.

SCHLOSSBERGER first suggested the use of an ammoniacal solution of protoxide of nickel for dissolving silk. Persoz proposed to use chloride of zinc, and Spiller used concentrated hydrochloric acid. J. Loewe recently described a new solvent, the cold alkaline solution of copper with glycerine, which is not inferior to the above, and with great dilution surpasses them. In very weak solutions the silk is acted upon slowly; if moderately concentrated, the silk swells up on moistening it a short time, and with a larger quantity it soon dissolves to a thick liquid, which can be filtered, although it filters slowly. By adding hydrochloric acid to the filtrate, the dissolved silk separates in the form of a white jelly; frequently this separation is very slow, and the filtrate appears like a cold solution of gelatine. Wool, cotton, and linen, after being in contact with this solution for hours, is neither attacked by it nor taken up by it. It appears as if the solvent power of the alkaline glycerin and copper solution only extends to the silk. In mixed fabrics the silk may be readily detected, and even quantitatively determined.

Silk which has been dyed black with iron salts dissolves with more difficulty and less completely, for the reason that the fibres are surrounded and protected by the insoluble oxide of iron. Such silk should be soaked for some time in sulphide of potassium or ammonium, and washed, and the sulphide of iron thus formed dissolved out with diluted hydrochloric acid. It then dissolves more readily, because of the partial removal of the iron. By treating the sample with diluted hydrochloric acid and metallic zinc, in special cases, this end may be accomplished. Silks dyed with other colors do not exhibit this difference in solubility, which depends upon the protecting action of the iron salts. In black mixed fabrics this treatment must precede the test for the other fibers. White wool acquires a blue-black color in the copper solution, but this is easily removed by an acid bath.

PORTRAITS IN WATCH GLASSES.

A PORTRAIT which is acquiring considerable vogue in the United States at present is described in *Anthony's Photographic Bulletin* as follows:

"Take an unmounted rather strong print, and trim the same somewhat smaller than the convex glass to be used; wet it thoroughly in clean water, and then lay it face up on a sheet of glass, blotting off the water; then brush over it a stiff paste, made out of gum tragacanth, and apply the same also on the inside of the convex glass, which ought to be carefully cleaned with ammonia; then lay the print on the glass, and on the top of the print a piece of smooth, tough paper, and rub out all the paste and air-bubbles with an ivory or bone paper-folder, the upper edge of which must be curved corresponding with the shape of the convex glass; the edge must also be sharp and smooth. Always work from the centre, using slight pressure, and frequently change the smooth paper on the back, which serves to protect the print from getting scratched and torn. After the print is perfectly mounted without showing either wrinkles or blisters, let it dry thoroughly, but spontaneously. Then grind the paper a little with fine sand paper, and immerse it in a small tin pan containing molten spermaceti (a good plan is to have the pan fitted into another pan holding a water bath, in order to just keep the spermaceti in a molten condition without heating it too much, in which case it would affect the albumen of the print, turning it into a nasty yellow that will spoil it entirely). It will only take from ten to twenty minutes to make the print perfectly transparent; then take it out of the spermaceti and let it cool off, and with a coarse rag rub off all the surplus spermaceti, laying the glass on a small cushion to avoid breaking. Now the picture is ready for painting. All white drapery, such as collars, laces, shirts, etc., also the corners of the eyes, are painted on the back of the photograph with flake white; jewelry, lips, eyes, flowers, and similar things are also colored on the picture itself, only care has to be taken to keep exactly to the outline. When this part of the coloring is done, take a second convex glass, put it over the photograph on the back and fasten the edges with adhesive paper; then mix the flesh color, and on the back of the second glass paint all over the face; then paint over the hair, to make it the tint and shade desired; the same is to be done with the drapery and all other parts of the picture. It is more convenient to do this work on a negative retouching-frame, in order to preserve the outlines better. When painted, back with cardboard.

"Mr. Kraus, the introducer of these pictures, contends that the formulæ already published, based on his original invention, are defective, for the reason that castor oil causes the pictures to become more or less opaque, especially after a few months' keeping. Spermaceti, on the other hand, will make them endure indefinitely."

NEPTUNIUM, A NEW METAL.

HERMANN, who published his first paper on minerals containing the metals of the tantalum group a third of a century ago, announces the occurrence of a new element, which he has named "neptunium," in a specimen of "tantalite" from Haddam, Connecticut (*Jour. prakt. Chem.* 1877, xv., 105). It is now seventeen years since the first element was discovered by the method of spectrum analysis, devised by Bunsen and Kirchhoff, and during the interval science has been enriched by the identification of the metals: caesium, rubidium, thallium, indium, and gallium. We learn with no little interest that by the older and more difficult means of mineral analysis the presence of a new metal has been detected. The specimen containing it was found on examination to be a mixture of about equal amounts of columbite and ferro-ilmenite, both of which species occur in the granite of Haddam. The metallic acids obtained from this specimen are present in the following proportions:

$$\begin{aligned} Ta_2O_5 &= 32{\cdot}39 \\ Nb_4O_7 &= 36{\cdot}79 \\ Il_4O_7 &= 24{\cdot}52 \\ Np_4O_7 &= 6{\cdot}30 \\ \hline & \ 100{\cdot}00 \end{aligned}$$

Hermann describes the method of separating the new body which rests on the inferior solubility of its soda salt in boiling water. Neptunium exhibits all the more important characteristics of the metals of the tantalum group, and is evidently a member of that group. It is distinguished from niobium and ilmenium in that its fluoride forms with soda an amorphous insoluble precipitate while the other metals produce crystalline precipitates which dissolve in twenty-five parts of boiling water; it can, moreover, readily be separated from tantalum, from the fact of its fluoride forming with potassium fluoride an easily soluble salt, the corresponding compound of tantalum requiring 10° C. 200 parts of water for its solution. The soda salt of neptunium colors a bead of microcosmic salt golden yellow, while the other metals comport themselves under these circumstances in the following manner: Tantalum, colorless; niobium, blue; and ilmenium, brown. Other reactions are referred to which serve to distinguish it. The atomic weight of the new metal, determined by an analysis of the neptunium-potassium fluoride, was found to be 118·2; this salt has the formula $4KFl + Np_2Fl_7 + 2H_2O$. The atomic weights of the metals of this group, it should be stated, form the following series:

Tantalum	176
Neptunium	118
Niobium	114
Ilmenium	104·6

As the author has but forty grains of the hydrate of the acid of the new metal at his disposal, he is unable to prepare metallic neptunium. He has, however, calculated its specific gravity and atomic volume on the asumption that neptunic acid, Np_4O_7, obtained by igniting the hydrate, is similarly constituted to the corresponding oxide of niobium; and he finds the density to be 6·55, and the atomic volumes of this group of metals to form the following series:

Tantalum		= 16·5
Niobium	$16{\cdot}5 + 1 \times 0{\cdot}5$	= 17·0
Ilmenium	$16{\cdot}5 + 2 \times 0{\cdot}5$	= 17·5
Neptunium	$16{\cdot}5 + 3 \times 0{\cdot}5$	= 18·0

Although the precipitate formed on the addition of soda to the fluoride of the new metal is, it will be remembered, insoluble, neptunic acid when fused with soda and treated with boiling water, dissolves in that liquid; as the solution cools prismatic crystals separate. Tantalum, under similar circumstances, behaves in the same way, with the difference that the crystalline deposit is, in this case, in the form of hexagonal plates.—*Academy.*

IRON AND STEEL MANUFACTURE.

IN connection with the working of the Bessemer process, a very simple invention has been suggested by Mr. T. A. Freeston, of Attercliffe, Sheffield, Eng., with regard to the construction of the lower part of the converter. Hitherto the arrangement in the vessels for the introduction of streams of air into the same, as required, has consisted of fireclay tuyeres of a nearly cylindrical form inserted in the lining of the lower part of the vessel, such tuyeres being slightly tapered at the lower end, in order to render them capable of resisting the pressure to which they are exposed. Now, Mr. Freeston's invention consists in dispensing with the use of such inserted tuyeres by forming in the lining of the vessel itself suitable perforations, through which the said streams of air are intended to be forced by the ordinary means. These perforations are formed in the "ganister" or other material of which the said lining is composed, by inserting therein tapered pins or plugs of metal, or wood, or other substance, and ramming the "ganister" or other material firmly round them. These pins or plugs are allowed to remain embedded in the "ganister" lining or lining of other material until it becomes thoroughly dried, either naturally by exposure to the atmosphere or artificially by being baked in a stove or otherwise, after which they are removed, leaving suitable perforations in the said lining. In order to secure the "ganister" lining or lining of other material to the bottom plate, metallic studs are employed, of a conical or other suitable form, adapted for fastening the "ganister" lining or lining of other material and metal bottom plate together as required.

Another invention connected with the Bessemer process has been patented by Mr. Hermann Schierloh, of Jersey City, N. J., by which he is able to manufacture an excellent quality of steel from Bessemer metal, and provides a means whereby Bessemer scrap, such as old rails and the like, may be utilized in the production of a cheap steel, capable of use for many purposes for which steel has not ordinarily been used, as well as for many for which an expensive steel is required. In carrying out the invention he heats old Bessemer steel rails, or any other Bessemer steel, in a suitable furnace to a rolling heat; he then flattens by rollers, hammers, or other suitable means, cuts the flattened metal into sizes to suit the purpose for which the finished product is designed, and covers these pieces of the flattened steel with the welding compound, which he terms a cherry heat welding compound, and which was patented by him in 1874. After the steel has been thus flattened, he cuts it into pieces of suitable sizes and proportions. He takes any desired number of the said pieces and covers or coats them with the welding compound. This compound may be applied to the pieces either by wetting the pieces with water, then dipping them into the compound in order to cause the latter to adhere, and then by a moderate blow or jar dislodging the surplus quantity of compound, but leaving a suitable coating upon the metal; or by simply sprinkling the compound in a dry condition upon the dry metal by means of a pouncing-box, a brush, or other suitable means or implement. The pieces being thus coated with the welding compound, aforesaid, are placed two or more pieces together in regular "piles," or in "box piles."

He prefers to bind the piles with wire to retain the pieces in proper contact and position with reference to each other, during subsequent treatment. The piles formed of the pieces, arranged together as aforesaid, are then placed in a furnace and brought to a welding heat. This done, the piles, while at a welding heat as aforesaid, are placed under a hammer and welded, and condensed by the action of the latter. When the welded and condensed piles have become too cold for further hammering they are re-heated and are then rolled or hammered to shape and size. Steel manufactured in this manner from Bessemer steel is very tough and strong; for example, a rod rolled hot to No 4 size or gauge may when cool be drawn out without annealing into rods No 14 gauge, thus displaying a degree of toughness and ductility greater than that of the best British iron. Moreover, steel made in this manner from Bessemer steel, when rolled or hammered to suitable sizes, affords excellent steel for general machine purposes, and also steel particularly adapted for railway tires and axles, inasmuch as it has a tensile strength (as ascertained from experiments privately made) of 146,000 lbs. per square inch. By thus producing at a cheap rate steel practically equal to cast steel for many purposes, he enables manufacturers and others to use steel in the production of many articles for which steel has hitherto been inadmissible. Furthermore, steel made from Bessemer metal by this process can be welded as readily as wrought iron, and its employment may be thus adopted for many purposes for which, by reason of the difficulty of welding, steel has not hitherto been ordinarily used.

In order to facilitate the annealing, coating, welding, and case-hardening of iron and steel, Mr. Eduard Blass, of Cleve, Prussia, proposes to employ a bath of molten salt, and he states that for the purpose of cleansing and brightening the surface of iron or steel in wire or other forms it is only necessary to pass it through a bath of molten salt, which has also the effect of annealing the metal without discoloring or scaling the surface, as in ordinary annealing processes. When the surface of the metal is rusty, it should be left in the bath for some time, according to the extent or depth of the oxidation. It is also advantageous to mix borax with the salt. The metal cleansed in this manner is at once fitted to receive a coating of other metal, such as copper, zinc, tin, silver, nickel silver, or alloys thereof, fused either in a bath separate from the salt bath, or under the salt in the same bath with it, so that wire or other pieces of iron or steel can be passed through the fused salt and subsequently through the molten metal, so as to become coated therewith. For iron in the spongy or pulverulent condition as it is produced by reduction of ore, the cleansing by means of the bath of fused salt is of great advantage in facilitating the union of the particles of metal by welding. In order to apply the salt bath to metal in this form, the salt is melted in an ordinary or rotating puddling furnace, and the iron sponge, mixed with a small quantity of quicklime or other suitable flux in the proper proportion, is added in such successive portions that the salt is not too much cooled by any one charge. The iron is left in the bath until the flux combining with the impurities of the sponge melts these out, whereupon the iron can be balled and taken out to be shingled or compressed. During this process, the iron being completely covered by the salt, is protected from oxidation, while the fluxes form a slag with the impurities of the sponge.

For case-hardening iron the salt is melted in any suitable vessel, and the articles to be case-hardened are immersed in this bath, and small quantities of dehydrated yellow prussiate of potass are added from time to time to the extent of 1 to 2 lbs. for every hundred-weight of iron treated. The pieces to be hardened are retained in the bath from five minutes to half an hour, according to the thickness of skin to be hardened, and are then immersed in a bath consisting of water 100 parts, with about 1 part of hydrochloric acid, about 5 parts of common vinegar, and about 1 part of salt. If the articles are required to present a silvery surface, they are afterwards immersed for a few minutes in a mixture of common vinegar and hydrochloric acid in about the proportion of 3 parts of the former to 1 part of the latter.

SELENIUM IN REFINED SILVER.—M. H. Debray.—It has often been found that ingots of silver of so high a standard of purity as 998 to 990-1000ths are very ill suited for the preparation of industrial alloys. The bad quality of this silver appears most striking in the alloy 950-1000th (first standard). The bars or plates are blistery, and when worked they display surfaces covered with grayish points which do not readily disappear on polishing, and which always reappear under the gilding. During the fusion of the metals, silver and copper, which form the alloy, a brisk ebullition is produced with projection of particles, even when working, as is customary, under a stratum of carbon. These peculiarities are due not to sulphur, of which not a trace is present, but to selenium. To detect this body in the silver we dissolve 100 grms. in hot nitric acid, at 34° Baumé. The trace of gold present remains in the form of very dense blackish flocks, which are separated from the solution. This latter is then precipitated with hydrochloric acid and evaporated to dryness, and without too much heating the acid liquid, it is clarified or filtered. The selenium is then found in the residue as selenic acid. It is boiled with a few drops of hydrochloric acid to convert it into selenious acid, and we add to the liquid thus obtained a solution of sulphurous acid which—especially in heat—reduces the selenious acid, and gives a black deposit of selenium, easily recognized. The source of the selenium is in the sulphuric acid used by the refiners in separating gold from the triple alloy of gold, silver, and copper. It is, therefore, very important to reject samples of acid containing this impurity. To detect the presence of selenium in sulphuric acid, it is diluted with four times its volume of water, and a concentrated solution of sulphurous acid is added to the clear decanted liquid. The mixture is then heated to 80°, when a precipitate of finely divided selenium appears, generally red.

PITTSBURGH.

We doubt whether the position of Pittsburgh among the manufacturing and commercial cities of the country and of the world is fully understood, notwithstanding all that has been said concerning it. The statistics of its production of iron and steel, its shipments of coal and petroleum, its manufactures of glass and other products of skill and industry, show astonishing aggregates, but one must see these things manufactured or handled—he must feel the pulsations of these great industries—or he will after all but poorly realize how great is Pittsburgh and how mighty are her works. Who can say that he comprehends the grandeur of Niagara until he has seen the deluge of its waters, or the vastness of our Western prairies until he has been whirled over them a whole day in a fast railway train, and then has not come to the end?

Business called us to Pittsburgh last week, and, although we have seen the city and its suburbs more instinct with life and energy than they then were, we never before saw so clearly how large a space these communities occupy in the industrial development of the country. Sink them out of sight and hearing and what a blank there would be! Nowhere is labor more honored than here; nowhere are idlers and ornamental people at so great a discount. The proportion of mechanics to the whole population must be greater than in any other large city of the Union. Enter a street car and two thirds of its occupants are sure to be workingmen, and the remainder are mainly their wives and daughters. At a street crossing, or upon any one of the long bridges of Pittsburgh, those who meet you work hard with their hands. The streets are noisy with the sound of wagons filled with merchandise, and the bosom of the Monongahela is often covered with barges and broadhorns holding acres and acres of Pittsburgh coal. Of the freight arriving by railroad, how a clearer sky, cleaner linen, and more delicate employments for their people.

But Pittsburgh and its suburbs are not nearly so smoke-enveloped and so barren of rural delights as the hasty visitor, or the traveler who sees the city from the window of a railroad car, might suppose. It is true that the central parts of the city and some of its immediate suburbs form a great grimy workshop; but men, women, and children do not usually live in a workshop, and so we find that other suburbs of Pittsburgh are aggregations of elegant homes, with only a blue sky overhead and a carpet of green on every hand. Allegheny City has an extensive and beautiful park, in the very center of its territory, of which any city in the country might justly be proud. Shady Side, where Pittsburgh's first iron enterprise was abortively established about 1794, and which is the home of ex-Senator John Scott, is a lovely spot. So is the country away from the railroad between East Liberty and Wilkinsburg; so is Swissvale; so is Edgewood; so is Sewickley. Other suburban environs of Pittsburgh are equally attractive. The actual fact is that, whereas in Philadelphia and other cities the home and the workshop are usually close together, and are frequently found under one roof, in Pittsburgh a large proportion of the business and working population live outside of the limits of the city proper.

One of the marked features of Pittsburgh is its comparatively modern development; another the tenacity with which it holds on to what it gains. Its first steamboat was built in 1811, and its first rolling mill was not built until 1813. Its prominence in the manufacture of steel cannot be dated further back than 1860. We may admit that much of Pittsburgh's growth is due to its favored position, but much of it is also due to the pluck and perseverance of its Scotch-Irish inhabitants—a people who come of the same stock that has given to this country many of its most ardent patriots, its renowned soldiers, its wise statesmen, its eminent jurists, divines, merchants, inventors and manufacturers, its railway kings, and chief magistrates. Why, for instance, should the manufacture of crucible steel have been first brought to perfection in this country at Pittsburgh and not elsewhere? Why should it be one of its leading industries to-day? Not because Pittsburgh enjoyed exceptional advantages for this manufacture, but because of the courage and faith of those who put their money into it. And how could Pittsburgh have sustained the manufactures it years ago built up, if, in the face of the fiercest competition it had been for one day dismayed or disheartened? The proof that it at no time means to surrender its place among the manufacturing cities of the country is seen in the struggles of its iron manufacturers during the past three years, and in the recently aroused spirit to make use of the most improved processes, regardless of expense, which is well illustrated in the establishment of the Edgar Thomson Bessemer steel works, and in the erection of the Lucy and Isabella furnaces. There are Danks furnaces at Pittsburgh, and natural gas is there used for fuel. In a smaller but equally significant way may also be instanced the introduction of improved machinery into the spring and axle works of J. S. Liggett. The need, too, of greater diversity in iron and steel and other manufactures is now fully comprehended, and we have no doubt that practical effect will soon be given to this conviction.

Pittsburgh will hold its own, and more. It is a mistake to suppose that the panic has permanently impaired its business prospects. It is busier and more prosperous now than it was a year ago. It may momentarily hesitate to pay the interest on an improvement debt which is not free from the taint of corruption, but it will not cease its marvelous activity nor abate a hair's breadth its claim to be the Birmingham and the Sheffield of America.—*Bulletin.*

ORNAMENTAL SCISSORS, KNIVES AND FORKS IN THE ROYAL GARDE MEUBLES IN DRESDEN.
(*From the Workshop.*)

large a quantity is iron ore and pig iron for home manufacture! and of that which the railroads take away, how many tons are iron and steel and their finished products! A population all told of over two hundred thousand, and all busy! If the prostrated South would only dignify white labor as Pittsburgh has done, what a wealth of restored prosperity the South would soon enjoy! Young gentleman, if you would know what it is to be a man and to be of some use in the world, go to Pittsburgh and go through its mills and factories and workshops. See what brain and muscle and machinery and energy can do, and, if you are tempted to complain of the smoke and dirt which wrap you about upon every hand as with a mantle, remember that it was through similar surroundings that England fought her way to the leadership of nations. We pity the man who has not seen Pittsburgh; we pity him the more if he has seen it and leaves it with a sneer at its smoke and dirt. One may be excused for not desiring to be sent to Pittsburgh when he dies; for the poor old woman's idea of heaven, that it is a place where she can sit in a clean white apron and sing psalms, is hardly capable of realization at Pittsburgh, except as to the psalms; but surely a live man can drink in more inspiration to manly effort in Pittsburgh than in cities which can boast

INVENTIONS AND IMPROVEMENTS ANNOUNCED ABROAD.

On Loading Silk, M. Milliquet says the mode of effecting it is to take 100 kilogrammes of silk, 300 kilogrammes of hydraulic lime, 15 kilogrammes of soda, and 15 kilogrammes of borax; but, he adds, these quantities may be varied at will. By these means there is much economy both in soap and fuel. In order to render the silk known as Saint Chamond supple, the water drawn clear from a bath of h draulic lime is used.

Cleaning Yar s by Friction.—An improvement in machinery, by M. Imbs, is described as consisting of the establishment of a pressure on the yarn at the point of crossing, and of friction of the yarn upon itself, by the employment of rollers acting upon cylindrical bodies around which the yarn is wound. It also includes the combination in the said machines of bobbins, so disposed as to wind off by the head, with rapid speed given to the yarn, without shock or vibration.

Shuttle Improvement.—Wonderful improvement is said to be produced in merinoes and other tissues by the introduction in the shuttle, at the end of the quill, or cop, of a small funnel-shaped piece of rubber, metal, or porcelain, with a small interior passage within it, which exercises a gentle and regular pressure on the weft. M. Vinal's name is attached to this novelty.

Dyeing Long Piles.—M. V. Garaud describes his method of dyeing long-piled tissues, or rather his mode of weaving them in double pieces, and not separating them until after they are dried, so that the extremities of the pile are supported during the whole process, whether simple or complex, and are not liberated till the operation is quite complete.

Jacquard Improvement.—An improvement in connection with the jacquard is announced by M. Vincenzy, which consists in a mode of application by which certain kinds of tissues are made without the employment of healds in the ordinary way, the new *jacquard au rabat*, as it is called, commanding the warp as completely as the healds in the ordinary apparatus. We should like to see this new arrangement.

A Novel Method of Ornamenting Velvet and Plushes is described by M. Imbs; it consists simply in laying given parts of the pile by any of the ordinary means, then clipping that which remains standing, either by hand or by machinery, and finally raising up that which had been laid, by means of brushing, beating, washing, or steaming, when, of course, it will stand up of its original length, and thus form the required pattern.

Extraction of Soap.—MM. Knab and Fournier have invented a process of extraction of soap from waste water after wool washing, which consists, in the first place, of separating the soap by means of such soluble salts as those of zinc, iron, manganese, or the salts of lime, obtained as a residue in the manufacture of precipitated phosphates. They claim the employment of a new agent, oxychloride of calcium, which is more surcharged with lime than those in ordinary use. After this operation, the whole of the water in which the soap floats is submitted to the action of the hydraulic press filter, which separates instantaneously the precipitated soap, leaving the cakes sufficiently solid to be dried either in the open air or by heat.

Quill Brushes for Combi g Engines are said to possess many advantages over those made with bristles. M. Gaspard says that they are formed of quill cut into little strips, and are mounted just in the same manner as hog bristles, that they not only last much longer than ordinary brushes, but do their work much more effectually.

Bri'iant Cotton and Hemp.—A method of giving to cotton, flax, hemp, jute, china-grass, etc., such a brilliant appearance that they may be used in the place of silk, is thus described by M. Magner, and which possesses, when worked up, much more strength and body than in their ordinary condition. The fiber is first cleansed from all greasy matter and other impurities, and made into bi-nitrated cellulose, this result being obtained by steeping the cellulose for twelve or fifteen minutes in a cold mixture of nitric and sulphuric acids, and afterwards treating it with such agents as peroxyde of hydrogen or bi sulphide of hydrogen. After being wa-hed in boiling and rinsed in cold water the material is steeped for a short time in an acetic solution, after which it is dried in partial vacuo at a heat of 60° to 65° C. It is then passed through a solution of soap, soda, and perchloride of tin.

Sorting Rags.—MM. Gaudchaux-Picard give the following method of sorting mixed rags, and treating those which are formed partly of vegetable with sulphuric, nitric, hydrochloric, or other acid, either liquid or gaseous, but preferable with hydrochloric gas in a dry state, when, after washing and beating, the vegetable matter will fall away in powder, and the wool is obtained the full length of the warp or weft, and capable of supporting all the operations of carding or combing, etc

A Mode of Bleaching Wool, and animal fibers in general, is described by MM. Knab & Fournier, as effected by a solution of glycerin and oxalic acid in pure water, the bleaching being rapid in proportion to the quantity of oxalic acid. Glycerin and oxalic acid being soluble in water, are easily got rid of by washing. The inventors especially claim the employment of glycerin baths as concentrated as possible, also of baths of acid, either pure or mixed with the various dressings employed in manufactures.

Olive-Tree Wood for Making Shuttles and Rollers is recommended by M. Borissow in preference to all others. It is said to be unaffected by the shocks to which shuttles are liable, sufficiently hard for rollers, not to be given to splitting, warping, or twisting, easy to work, and unaffected by dampness or heat.

A New Mode of Decorating Muslins and other tissues is announced by M. Wolf, which consists simply of tracing out the design with a solution of alum—20 grammes to a liter of water—and then painting in water-color; or the colors may be mixed with the solution, and the ornamentation effected in one operation.—*Textile Manufacturer.*